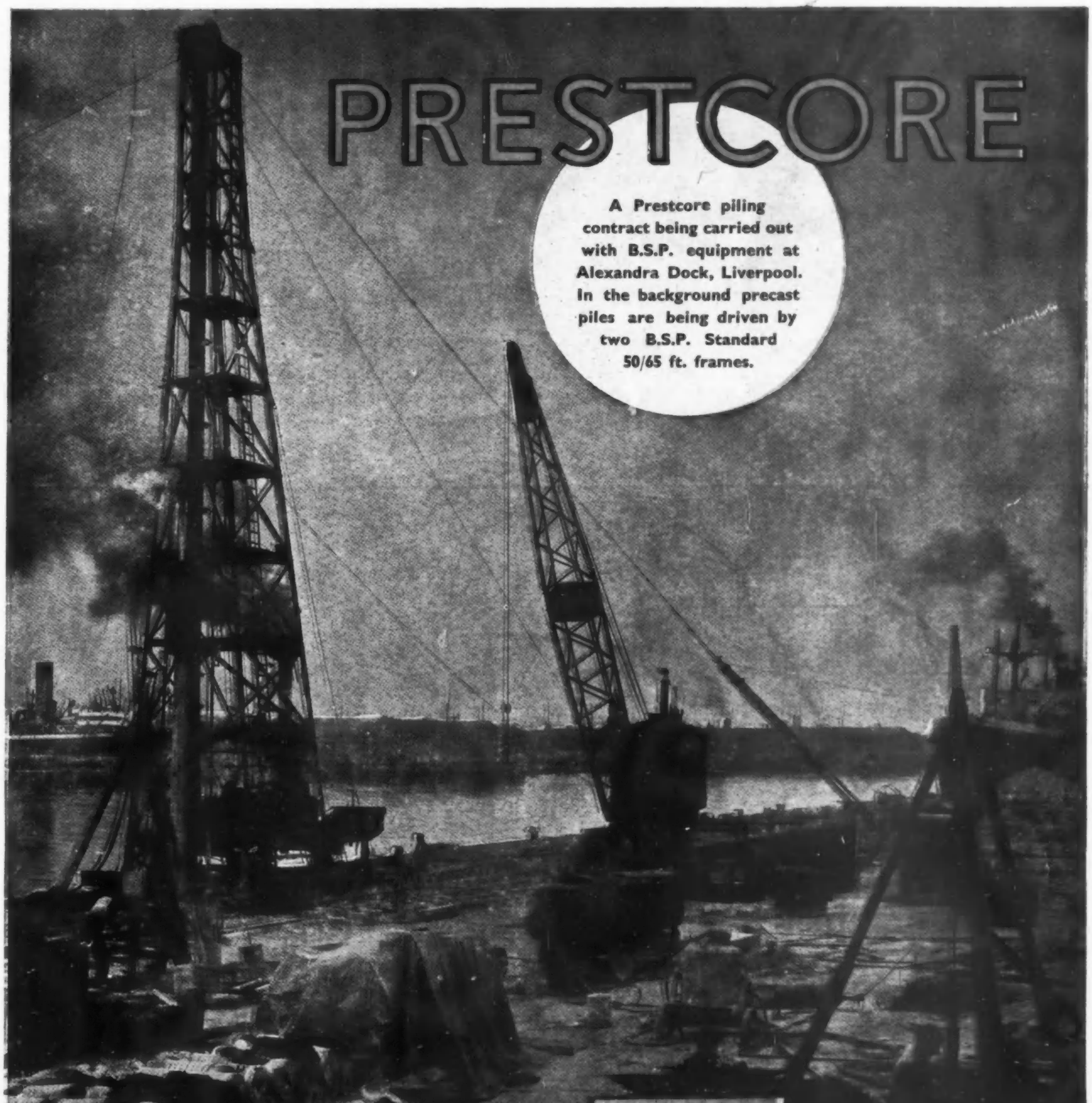
MAR 30 1950

The Dock & Harbour Authority

No. 343. Vol. XXX MAY, 1949 Monthly 1s. 6d.



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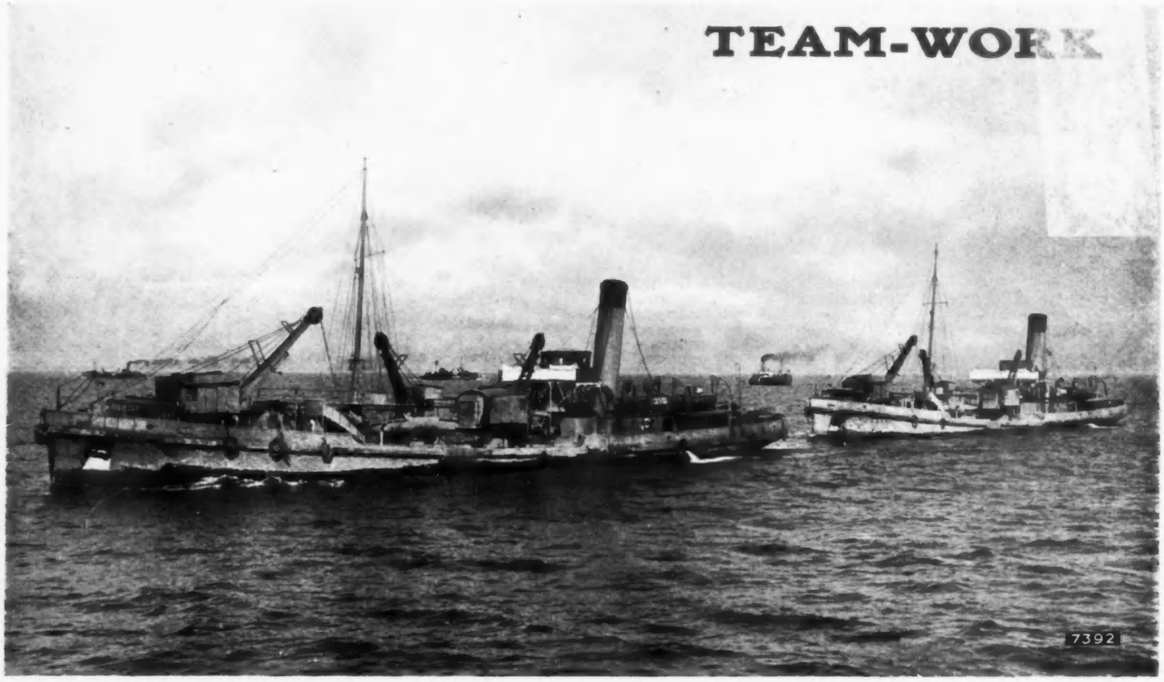

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The Dock & Harbour Authority

No. 343. Vol. XXX MAY, 1949

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Editorial Comments

The Port of Manchester.

The City and Inland Sea Port of Manchester, standing on the river Irwell at its confluence with the Irk and Medlock on the south-east corner of Lancashire, has a population of nearly a million, and owes its commercial importance to its position in the centre of a network of railways and canals which makes it a great distributing centre. It is the headquarters of the cotton manufacturing industry, and also has important engineering and chemical works.

One of the chief causes of Manchester's rise to fame during the past 60 years was the construction of the famous Ship Canal which was begun on the 1st November, 1887, and after many vicissitudes was completed in December, 1893. Before this Canal was opened, the water connection between Manchester and Liverpool was by the rivers Irwell and Mersey, and from the 17th century onwards, the navigability of these rivers had been gradually improved. As the need for further improvements to the river way became more pressing, a number of schemes were put forward from time to time, and eventually, the Bridgewater canal was built; this however, still failed to satisfy the growing demand for direct access to the sea, so that eventually, the Ship Canal was planned. An interesting account of the present day port and waterway forms the leading article for this issue.

As far as the present day working of the Port of Manchester is concerned, it is encouraging to read that the rate of cargo handling compares very favourably with other United Kingdom ports, and since the National Dock Labour scheme has been put into effect, some improvement in the rate of loading and discharging is to be observed in comparison with the old casual system. At the same time however, it is to be regretted that in general, there appears to be among dock labourers themselves a lack of appreciation of the benefits in the shape of welfare and security of employment which they now enjoy.

It is to be hoped that the increase in tonnage per gang hour will be still further improved, and that the men will agree more readily to the introduction of modern mechanisation methods wherever these are considered advisable.

The Essequibo River, British Guiana.

The Evans Commission set up by the British Government to investigate the possibilities of relieving over-population in colonies in the West Indies recommends, *inter alia*, that various industries and plantations should be established in British Guiana and British Honduras so that in the next ten years 100,000 settlers, principally from the over-crowded West Indian Islands, could be absorbed in these two Colonies.

As a first step towards implementing the recommendations contained in the report, the possibilities are to be investigated of dredging channels through the mud bars in two rivers—the Essequibo and the Burbice, which are recognised to be of the first importance—to enable the lower reaches of the rivers to be navigated by ocean going vessels.

At present the exports of the country, consisting chiefly of bauxite, cocoa, bananas and timber, have to be carried over the bars in shallow draft coastal vessels. The dredging of the channels should therefore bring about lower freight charges on all classes of exports and so help to expand production in the Colony.

Moreover the passages through the bars would at once permit the shipping of cargoes of greenheart timber from stretches of forest much higher up the Essequibo River and would thus cheapen handling costs, an important factor in the development of the use of greenheart.

The "Report on West Indian Shipping Services," recently issued by the Commonwealth Shipping Committee, states that there are vast reserves of hard wood in British Guiana, the most important of which is greenheart, which is used principally for the construction of dock gates, their meeting faces and those of floating caissons, and as piles for many forms of marine construction. The United States requires great quantities of greenheart for piling, and the demand in the United Kingdom is rapidly increasing owing to the embargo placed upon the purchase of pitch pine from the United States, due to the necessity for restricting dollar purchases. Also, as greenheart has a longer life and a greater resistance to marine borers, the present demand for the commodity greatly exceeds the supply.

We are also informed that in addition to the foregoing, investigations are being carried out as to the construction of an irrigation regulator at the Bona Sika head waters of the Burbice River, together with an irrigation canal project from that river, which will enable an expansion of the existing plantations of cocoa and bananas to be put into effect.

The Consulting Engineers for the investigations are Messrs. Coode, Vaughan-Lee, Frank and Gwyther, and the survey is being carried out by Mr. George E. Bennett, who was for ten years, up to 1940, chief engineer of the Port of Bombay.

In any scheme for development of natural resources and production, it is of the utmost importance that the highest priority should be given to ensuring the adequacy of the facilities of existing waterways, ports, railways and roads, and in the present instance this has been effected. Such schemes as the above are part of the Government's general policy for the development of the Colonies of the British Empire, and it is to be hoped that they will be attended with the success which such public works deserve.

Editorial Comments—continued

Compression Tests on Docking Blocks.

On a subsequent page we publish some extracts from a Report upon docking block tests carried out by the Stanley River Works Board, Queensland.

The full report is, unfortunately, too lengthy for complete publication, but the results of tests upon assembled block stacks, which are naturally of great importance, together with the summary and notes upon the Advantages and Disadvantages of Pine Caps, will be found to contain much useful data.

As will be seen, the stacks of blocks tested were composed wholly of timber, and the results seem to indicate certain advantages where the heaviest loads are to be dealt with, due to the resilience of such stacks compared with stacks composed partially of unyielding iron or steel.

The Author's remarks as to the use of anti-splitting bolts, and his general conclusions and summing up of the results of the tests, will, we think, be of interest to our readers.

Highways for Seaways.

Under the above title, Lord Sandhurst, Chairman of the British Road Federation, Ltd., writes an interesting article upon the subject of access to docks.

It is true to say that from the earliest times of international trade, the roads to ports in every country have been of the greatest importance. Consequently, all major roads in Great Britain, even before the Roman occupation, led to and from the ports then in existence. When, however, the inland waterways and railways were built in the 19th century, long distance haulage was naturally carried out on these new traffic routes, and subsequently many of the canals—which competed with the railways—were purchased by the latter, allowed to fall into disrepair, and finally abandoned.

It was not until after the motor vehicle had been perfected during the 1914-18 war, as a means of transport, that the use and importance of roads in our system of transportation after years of disuse again became apparent. Serious competition between all forms of transport then became acute, and that of the roads for various reasons was considered unfair. This position was, however, to some extent mitigated by various forms of legislation.

It is interesting to note, in studying the question of transportation in Great Britain, that, in the Port of London, the earliest docks—Surrey Dock and London Dock, built before the construction of railways—are still without railway access; so likewise are the majority of the riverside wharves in the Thames, which are outside the jurisdiction of the Port of London Authority.

On the other hand, Tilbury Dock, built in 1884-86 by the London & India Dock Company, in conjunction with the London, Tilbury & Southend Railway Company, was built with the idea that the majority of its imports and exports would pass over the railway. To this day, road access to this dock and to the quaysides themselves is more or less inadequate and cannot be perfected without drastic alterations to the existing layout.

Somewhat similar instances are in existence at some of the other ports of the United Kingdom, particularly those previously owned by the Railway Companies, who probably regarded the docks less as a source of profit in themselves than as a means of supplying freight to the Company's rolling stock.

Anyone who has seen the congestion in the vicinity of the docks and riverside wharves of London, involving hours of time wasted by lorries waiting in the narrow streets to be loaded or unloaded, will realise the urgency there for road improvement and the necessity for further arterial roads for the use of lorries visiting dock and wharf areas. The access road to the Royal Docks group of London, completed in 1934, is a precedent and an example which should be emulated in many other places.

Now that our ports, docks and transport system generally are nationalised, the present time seems to be most opportune for the whole question of road, rail and canal transport to be revised, and, by bold schemes of modernisation and new works, to so organise and unify these services that each form of transport can play its part in carrying those classes of raw materials, merchandise and foodstuffs best suited to them.

It is to be hoped, therefore, that the reports and recommendations of the several investigations made under the auspices of the Ministry of Transport upon roads to ports, and in the case of the Port of London, the schemes of the Cities of London and Westminster and London County Council in respect to town planning and roads generally, will soon be co-ordinated and, with the aid of the Special Roads Bill now before Parliament, brought to some degree of finality and to the stage of actual construction.

Bulk Sugar Handling.

Towards the end of last month a notable experiment in the transportation of sugar was undertaken by Messrs. Tate & Lyle, Sugar Refiners, London, with the approval of the Ministry of Food. For the first time 5,000 tons of sugar was brought to this country from the West Indies, in bulk in a ship's hold, instead of bagged.

As a result of this method, the importers had estimated a saving of £7,500 on jute bags and with the use of grab plant unloading into lighters it was thought that the cargo of sugar would be cleared in 24 working hours instead of the usual 5 days. A spokesman of the Company intimated that it was confidently expected that by the new method of handling, a saving of the order of 30s. per ton could be effected, thereby reducing the cost of sugar to the consumer, provided that no obstruction or difficulties were experienced.

However, it appears that at the outset there was a thirteen days' delay in commencing operations, due to disagreement between the Stevedores' Union and the discharging agency over unloading rates, the former apparently having asked for payment for mechanical unloading on a similar scale as for bag unloading. This delay is estimated to have cost nearly £2,000 in extra mooring fees and demurrage rates to the shipowners.

A Union official is alleged to have stated that although the Union was not against mechanical unloading their members must be protected, and it seems to us that this reluctance to give up a bargaining position by commencing unloading pending negotiations, shows a disregard of the public interest, and a lack of vision; moreover it betrays a mentality opposed to progress by mechanisation. It appears logical, by turning round ships in, say, three 8-hour days instead of five, as at present, that an overall increase in work for dockers would result, whatever reduction in labour per ship was involved, for each ship would return several more times in a year than formerly, a circumstance bringing far-reaching results which would be to the benefit of all concerned.

The whole question of the causes of unrest and restrictive practices among dockers appears to require thorough investigation, not only in this country, but throughout the world. We understand that a full report upon the experimental bulk handling of sugar will be made to the Ministries of Food, Transport and Labour, and it is to be hoped that the result of these investigations will be made public as they are likely to prove of considerable interest.

Hydraulic Model of the Fraser River.

With reference to the articles and correspondence on the subject of Tidal Models which have appeared in recent issues of this Journal, it is interesting to learn that an hydraulic model of the Fraser River, in British Columbia, comprising the whole estuary from New Westminster to the Strait of Georgia is to be constructed in the grounds of the University of British Columbia at Vancouver.

The purpose of the model is to solve many problems encountered by the Public Works Department of Canada in connection with erosion, channel regulation and navigation. The request for such a model was put forward by the Public Works Department who approached the National Research Council of Canada for its support in carrying out the necessary studies. Certain advantages in having the model built in the University grounds in preference to the Council Laboratories in Ottawa were apparent; the proximity of the model to the prototype, ease in acquiring and checking the field data and closer co-operation between the Public Works Engineers and the Model Research Staff made the choice decisive.

The area of land kindly allocated by the University Administration is now being cleared, but before any actual construction of the model can begin, much field data must be acquired and further preliminary studies made in connection with scales and bed-load material. The model will be constructed outdoors, with suitable protection, and will have its own independent circulating system. It will have an erodible bed with a distorted scale and be subject to the varying tidal influences.

Aerial view of part of the terminal deep-water docks at Manchester with No. 2 grain elevator at the head of the long dock.

The Port of Manchester

Ship Canal Serves Important Industrial Area

(SPECIALLY CONTRIBUTED.)

AMONG the ports of Great Britain, indeed, among the great ports of the world, Manchester is unique. The Port of Manchester should be regarded not as a single system of docks at the end of a canal, but as a deep-water harbour extending inland for thirty-six miles from Eastham Locks, where it meets the tideway of the Mersey, and embracing on its route a number of highly developed manufacturing centres each with its specialised industries and its own modern port equipment.

Most ports have evolved gradually round a natural harbour as piecemeal construction has kept pace with trade expansion. Manchester, on the other hand, was planned completely and scientifically as a new and easily worked port where no port previously existed. To-day, as a result of the combined skill, foresight and perseverance of Daniel Adamson, a prominent Manchester citizen, and Leader Williams, the great engineer, ocean vessels from all over the world are able to load and unload far inland at the very centre of the busiest industrial region in Britain as quickly, easily and efficiently as at any other port in the world.

Unhampered, as it is, by any combination of swift or sluggish tides, shifting channels, banking sand or any of the other natural limitations usually imposed on such undertakings, the port has, since the time of its opening, grown and changed in such a way that it has always tended rather to anticipate the requirements of trade and commerce than to wait for needs to arise. That is not to say that the birth of the Ship Canal was easy and effortless: the fight for Parliamentary powers was protracted and as soon as legal difficulties had been settled they were replaced by the twin problems of construction and finance.

The raising of capital proved extremely difficult, but the money was eventually forthcoming—thanks to the pride and confidence the majority of the ordinary citizens had in Daniel Adamson and Leader Williams and their fellow pioneers.

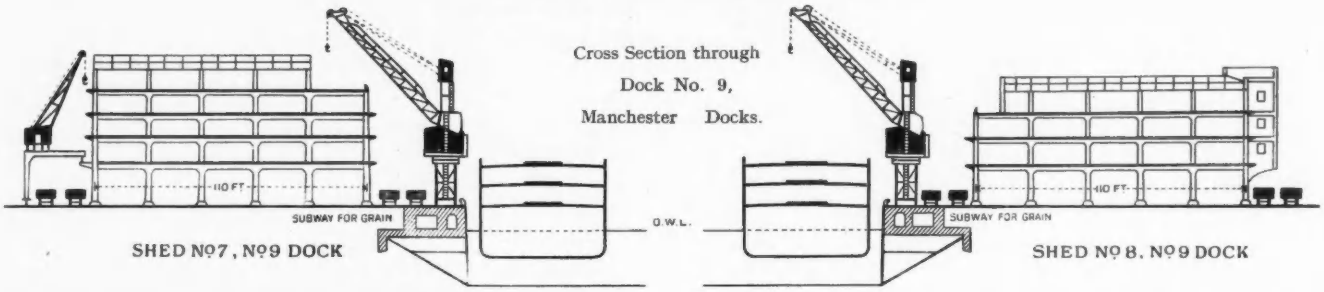
The Manchester Corporation came to the aid of the undertaking, lending first £3 millions and later £2 millions, and in one way and another the total initial cost of £15 millions was covered. To-day the authorised capital exceeds £21 millions.

Wide Area Served by the Port

The real significance of the port lies in the fact that it provides the nearest and most convenient port for a vast industrial area of England which includes the greater part of the South Lancashire cotton area, the whole of the Yorkshire woollen area, the steel and coal area of Sheffield, Rotherham and Chesterfield, the textile area of Nottingham, the Potteries and the Black Country of Birmingham, Coventry, etc.

There is, indeed, a much larger population within a hundred miles radius of Manchester than within a similar radius of any other port in the Kingdom, including London, and the extent to

The Port of Manchester—continued



Aerial view of Eastham Locks leading to the Port of Manchester

which this population of over eighty millions is dependent on the trade of the Manchester Ship Canal can be judged by examining the traffic returns since the waterway was opened to the shipping of the world by Queen Victoria in 1894.

In its first year the traffic tonnage was just under a million and the revenue £98,000. Ten years later, in 1904, the tonnage was nearly four millions and the revenue £418,000. For 1938 the figures were nearly 6½ million tons and £1,300,000; in 1948 the tonnage was over eight millions and the revenue £2,200,000. The total tonnage in 1948 was the highest yet reached, showing an increase of 1,288,000 tons over 1947; the increase in exports accounting for over half-a-million tons.

The total export tonnage rose to over two million tons—a figure which has only once been exceeded since 1929. The imports for the year 1948 rose by 789,000 tons, to which increase petroleum products contributed substantially.

The port is linked with all parts of the world by many regular shipping lines and it enjoys a fair share of coastwise trade. Manchester is the hub of one of the most complete systems of inland communications by rail, road and water in the Kingdom. Merchandise and raw materials for export and import pass directly between ship and railway wagon, lorry or barge, which means that goods are conveyed straight from every ships' berth to every town in the country with a minimum of handling.

The Manchester Ship Canal Company undertakes all services and remains responsible for imported goods until they are loaded for despatch to the owner. The fact that the docks at Manchester are modern and well equipped, results in an absence of congestion and less delay than is experienced at ports where the services are not under single control.

The extent to which the port serves the Midlands is not generally realised. Over rail, road and Canal, the Midlands import via Manchester grain, scrap metal, timber, asphalt, cotton waste, fuel oil, paper; and export iron, steel, machinery, cars and hardware.

The Canal is 36 miles long and it consists partly of the canalised sections of the Rivers Mersey and Irwell, and partly of virgin cuttings. It is deep and wide enough to accommodate vessels of 15,000 tons deadweight capacity and many large vessels pass through the tidal locks at Eastham to and from the Mersey every day.

It is not intended in this article to describe in great detail the dock estates, but it will be of interest to mention a few facts in connection with the service which the Canal renders to Manchester and the towns besides its banks. The first important point after entering Eastham Locks is Ellesmere Port. Here, where the Shropshire Union Canal terminates, an important manufacturing centre has developed since the Ship Canal was completed.

Modern Equipment

The docks and wharves are fully equipped with transit sheds and warehouses, coal tips, and a grain elevator with a capacity of 20,000 tons; a deep-water wharf is provided with direct rail

Aerial view of Ellesmere Port

The Port of Manchester—*continued*

facilities, modern cranes—lifting up to 10 tons—and a double unit coal conveyor capable of handling 800 tons an hour and designed to obviate the practice of moving ship. Amongst the industrial undertakings which are centred on Ellesmere Port are grain milling, chemical manufacture, paper and board manufacture, oil and tar products and road dressings. At the eastern end of Ellesmere Port and somewhat remote from the main concentration of industries are Stanlow Oil Docks, which during recent times, have developed at a remarkable rate until to-day Stanlow has become Britain's second oil port. The two deep-water docks, specially equipped for the safe handling of low-flash oil and spirit, are situated on the isolated north bank of the Canal on a narrow promontory between the waterway and the tidal Mersey estuary. Pipe-lines from the docks carry the oil and petroleum direct from the tankers to storage tank farms and refineries on the other side through subways under the bed of the Canal. On the South bank, where the leading oil companies have refineries, centres for storage and distribution and for the conversion of by-products, there is a lay-bye 600-ft. long for the discharge of heavier oils and for loading into tank barges.

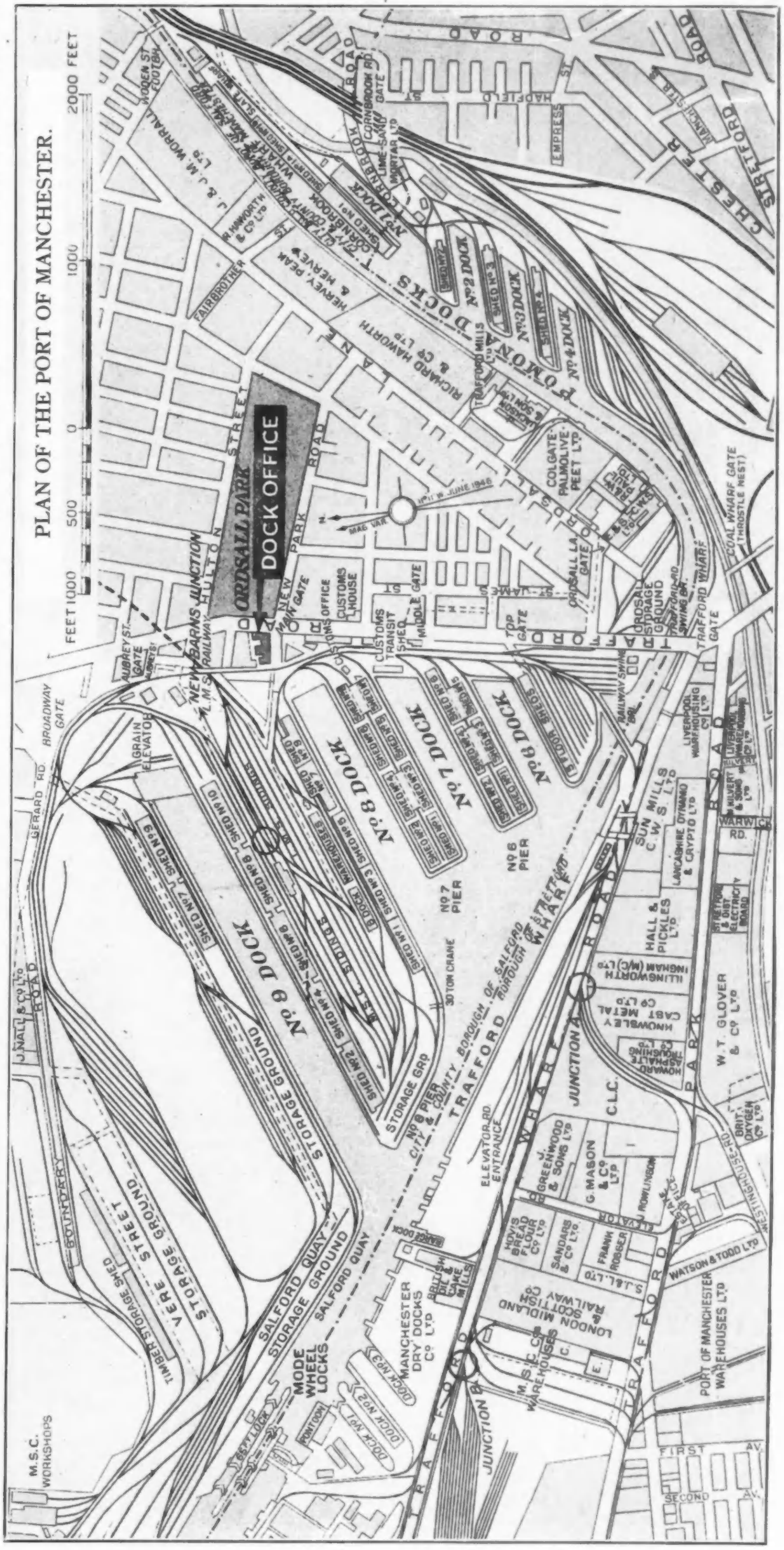
New Oil Refinery to be Constructed

In pursuance of the Government's policy as part of the country's recovery programme to promote the refining of oil on a larger scale in this country, the Shell organisation has chosen Stanlow as the site for the erection of one of their large refineries. The Shell plan, which involves an expenditure of £15 millions, will provide for the refining of crude petroleum; in order to make their plan effective the oil company is looking to the Canal Company to provide additional discharging facilities to deal with the development of this new traffic.

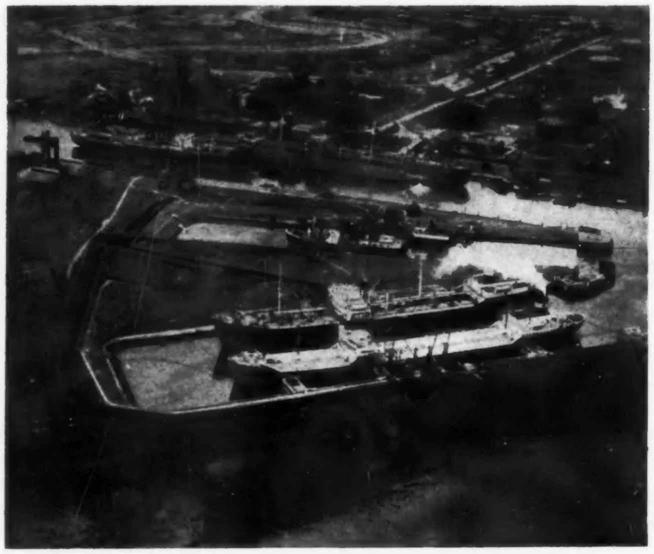
Crude petroleum for refining will come forward in big tankers of 28/30,000 tons with a draft of 34 ft.; their beam will be too large for them to pass through Eastham Locks, consequently it is not possible for the new dock facilities required for this traffic to be provided at Stanlow Oil Docks. They will, therefore, be constructed near the entrance to the Canal adjacent to Eastham Locks. The Parliamentary Bill which it has been necessary to promote to carry out this project has had its second reading and is expected to go before a Select Committee of the House of Lords in April; the powers sought will enable the Company to secure the land needed for the works and to construct the oil dock with its entrance lock and jetty and to provide for the formation of a deep approach channel in that part of the Mersey estuary which the Company is already empowered to dredge. The estimated cost of the whole of the works will be £4 millions and it is anticipated that the new dock will take approximately three years to construct.

Connections with Canal System

At Runcorn—seven miles above Stanlow—there are six docks with a water space of fifteen acres. Here the Bridgewater Canal and the Weaver Navigation join the Ship Canal. While not one of the most important sections of the Canal, Runcorn handles a considerable variety of traffic, including pottery materials, road stone, timber, coal, salt, pitch, grain, hardware and chemicals.



The Port of Manchester—continued



Aerial view of Stanlow Oil Docks

From Runcorn to Partington—a distance of fifteen miles—the Canal consists of some twelve miles of almost straight virgin cutting through red sandstone. Partington is an important coaling centre and from here large quantities of coal have been exported to many parts of the world during 1948. Partington is well equipped for the handling of coal exports with railway sidings totalling twenty-four miles, serving six coaling tips.

From this point up to the terminal docks, industry crowds down to the waterway. Just before the docks are reached, the Canal bends and the area enclosed in the angle has been reserved for factories and depots.

From the commencement this area has attracted industry, and, in Trafford Park alone, which is one of the busiest manufacturing zones in the world, there are over 200 firms employing some 20,000 workers. On this estate and on the Barton Dock estate hard by, the importing and processing of materials from overseas is one of the principal activities, and in occupations of this kind Transatlantic enterprise is frequently evident. An early settler near the docks was one of the largest electrical engineering works in the country, whose workers to-day—like those of other great manufacturing undertakings in the area—are counted in thousands.

The convenience of the dock area for supplying a population greater within a hundred miles than of any comparable area in the country is responsible for the location of many distribution depots for food and drink. Other industries represented on the dockside estates are branches of chemical manufacture, machinery, of building materials, concrete, joinery and metal goods.

Passing through Mode Wheel Locks—the last of the five locking systems—vessels find themselves at the terminal docks. The terminal dock estate covers an area of approximately 700 acres, with a water space of 179 acres. There are four docks for ocean-going vessels ranging in size from 850 feet long by 225 feet wide to 2,700 feet by 250 feet wide. Beyond these lie four smaller docks for coasting vessels. The quays total over 5½ miles long and total quay and storage area is over 280 acres. Trafford Wharf alone is 2,500 feet long and Salford Quay 1,100 feet long. Transit sheds to the number of forty line the dock sides, and there are eighteen warehouses of which thirteen are of seven floors. Bonded warehouse accommodation is provided and there is extensive open storage for timber which, since the war, has been considerably extended in order to meet increased imports.

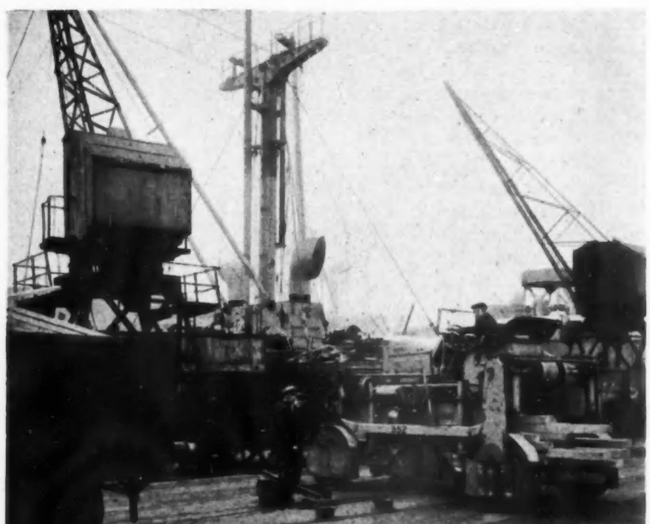
A feature of the port is the mechanical handling of timber. A fleet of Ross Carriers, supplemented by tractors and trailers, is provided for the purpose of taking timber from the ship's side and running it to the storage grounds in one movement. By the use of these machines, the capacity of ships' berths has been doubled and in some cases trebled, as cargo can be discharged without encumbering quay space. Every quay is directly linked with the railway systems of the country, the Company's own railways intersect the dock estate and comprise over 200 miles of track, and other lines are leased or worked. There are 73 locomotives and over 2,600 railway wagons for dock haulage work. The Bridgewater Canal, owned by the Manchester Ship Canal Company, the Shropshire Union Canal, the Weaver Navigation and other waterways connect the port with virtually the whole of the country's inland navigation systems. Cranes of different types, designed for their special purposes—including floating cranes for heavy lifts—exceed 300, and these have recently been supplemented by a considerable number of mobile cranes to expedite quay work.

One of the dominating features of the port is the large grain elevator, which stands at the head of No. 9 Dock. This elevator has a storage capacity of 40,000 tons or 1½ million bushels in 341 separate storage bins. Grain can be discharged from vessels on to the bands in subways along the northerly and southerly quays of No. 9 Dock from six berths at a time. In addition to the Company's grain handling and storage facilities, there are, along the water front, many private concerns with their own equipment.

Future Developments

Looking to the future, the Port Authority has drawn up what may be described as a three-term plan for the further development of the port: there is a short-term plan covering the next two years, a middle-term plan for another five years, and a long-term plan which looks ahead for the next ten years. Each step will be subject to improvement or modification as it becomes due. The aim is to give Manchester an even stronger place than it had before the war as the inner gateway to the industrial heart of England. The five-year programme includes the modernisation of the general electric lighting of the Manchester Docks and the extension to the locks at Latchford, Irlam and Barton. It is also anticipated that at the end of five years the whole of No. 8 Dock, No. 7 Dock North, Salford Quay and No. 8 Pier will have been completely electrified and provided with electric cranes and electric capstans.

One of the major items in the programme is the erection of a series of extensive warehouses for the accommodation of cotton and general cargo. These have been made necessary partly by the destruction, during the war, of a number of warehouses and

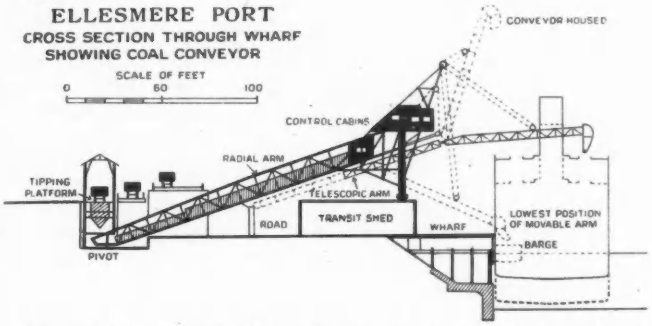


Ross carriers unloading timber at Manchester Docks

The Port of Manchester—continued

partly by the developments which are expected in the use of Manchester as a cotton port.

It is the determination of the port, therefore, to keep pace with the demands of industry, and its record during the fifty-five years of the Canal's existence shows that not only has it kept pace but that it has had some success in anticipating demands eventually to be made upon it and that, where it has been able to do so, it has provided facilities which have encouraged enterprise and expansion.



The port is a dominating influence in the life of the city: the livelihood of many thousands depends directly upon it and, indirectly, the livelihood of tens of thousands more; while it affects, in one direction or another, the welfare of a great population—and that the largest and most closely packed in the world. In its turn, the port depends on the support of this population and, above all, upon the shippers and industrialists.

Dredging Problems and Soil Mechanics

By HERBERT CHATLEY, D.Sc. (Engrg.), M.I.C.E.

In several papers on dredging and river control, the writer has alluded to the importance of applying the methods of soil mechanics to dredging questions. (See in particular "Dredging Machinery," Journal Inst.C.E., April, 1945, p. 75.) It is the purpose of this note to enlarge somewhat upon the matter.

The following items are of special importance:—

(1) The bulking of disturbed material, or the relation of "barge measure" to "in-situ" volumes.
(2) The dilution of material pumped in suction dredging.
(3) The settlement in hoppers and spoil basins.
(4) Shearing strength of submarine materials and their resistance to cutting.
(5) Energy required to break up a consolidated paste into a fluid suspension.
(6) The stability of submarine banks of sand or silt.
(7) Conditions of erosion and accretion.

Practical rules of thumb have been developed in many cases for all these matters, but none of them are entirely satisfactory and they are generally based on limited experience.

It was the peculiar merit of Terzaghi to have shown how the physical properties of wet granular masses could be related to grain size, chemical constitution, water content, pressure and age. He developed experimental apparatus and a mathematical technique for dealing with this subject and showed what an important part was played by viscosity and surface tension. His book, "Erdbacmechanik," published in 1925, marked an epoch, and the science of "soil mechanics" took on a new life altogether. Of course, there had been workers before him, but no one had seen as clearly as he how fundamental was the role of water within the interstices of sand and silt.

One of his earliest notions was the value of the "void ratio". This is the ratio of the empty or water filled space to the volume of the actual solid grains. Many others, the writer included (see "Trans. Soc. Engineers," June, 1922), had noted this as one of the various properties of granular material, but no one had realised that the only proper basis of measurement in such cases was the volume of the solid grains, because, speaking broadly, this is the only really constant quantity in a bewildering variety of conditions. The degree of packing is very well expressed by the void ratio, which varies from zero for completely solid rock to perhaps twenty for a watery jelly. This void ratio, which he now calls "e," is a most useful quantity and may be applied to items (1) and (2) with great effect.

In dredging practice there is always some difficulty in deciding what results have been achieved. If the excavated bed is sounded and a calculation made of the volume removed, there may well be a doubt as to the accuracy of the measurements, the reliability of the previous survey and the degree, if any, of silting or scouring that may have occurred after the previous survey, or after the dredging, or even between the dredging and the new survey. Again, if the quantity in the hoppers is reckoned ("barge measure") doubt arises as to the quantity of water added to the spoil in the process of dredging. Experience often indicates that "barge measurement" is 25 or more per cent. greater than the in-situ volume, but it may be less and is very often more. If, however, only the actual solid grains are considered, there can be no ambiguity as to the amount put into the hoppers. In most cases the specific gravity of such grains is about 2.6, so that if the weight and volume of the hopper load are known, the weight or volume of the actual solids can be computed. Thus if 1,000 cubic yards is the volume of a hopper load and it weighs (measured by the change in ship displacement after loading) 1,000 tons, the specific gravity of the mixture is 1.33 (1,000 cubic yards of fresh water weighs 750 tons), and on the assumption that the grain density is 2.6, the volume of actual granular material can be readily calculated.

Analogous methods may be applied to the dilution of material which is to be pumped in suction dredging. Experience shows that with coarse sand, boulders and the like, it is usual to add some five volumes of water to the bulk in-situ volume of the material when pumping. (This does not apply to mud.) The void ratio of such material is usually about one, i.e., the in-situ volume is about half interstice. Thus in the mixture the void ratio is about 11, and the total volume 12. As the diameters vary as the cube roots of the volumes, the space occupied by each particle in the mixture is about cube-root-of-twelve, say 2.3, grain diameters in width, so that the average space *between* grains is 1.3 grain diameters. This clearly allows grain to pass between grain without impediment. If, however, the grains are so small that combined water may adhere to their surfaces in amounts comparable with their own volumes, a plastic jelly may permit quasi solid or "dry" pumping. Thus the pumpability is a function of void ratios and grain sizes.

These are only general illustrations and the subject may be greatly enlarged.

The next item on our list is the settlement in hoppers. Coarse sand, gravel and the like settle rapidly, but fine sand, silts and clays settle slowly. Soil mechanics shows that the viscosity of water is here of great importance. The resistance to the forcing out of the water from the mixture is due to it, the only force acting to encourage it being the buoyant weight of the sand grains. With fine grains, apart from the fact that only very small current velocity is required to keep them in suspense, the small interstices develop high viscous water resistance and are themselves narrowed by adherent water in the "adsorbed" condition. Thus it is of the highest importance to pump thick mixtures if the grains are small, and the problem is interlocked with that of dilution in pumping.

The resistance of bed material to cutting, whether it be by the edges of buckets, the blades of rotary cutters or the edge or grid of a drag suction dredger, is dependent on the physical nature of the soil. This may be of soft rock, which gives a true shearing fracture comparable to that of ordinary structural materials, a plastic jelly such as soft clay, which also shears like structural material, or an intermediate form such as sand in which the principal source of resistance is the re-arrangement of the grains within a comparatively thick zone of shear. This last may be surprisingly high, since shearing involves the climbing of grains out of closely packed arrangement into a relatively open formation and in effect means an actual small lift of the whole of the

Dredging Problems and Soil Mechanics—continued

superposed material. This is the famous "dilatation" phenomenon, in which unidirectional compression causes "expansion" of the material acted upon.

Another interesting problem is that energy required to reduce a granular mass into what the physicists call a "suspension". This energy forms part of that absorbed in pumping. Whereas in the case of coarse sand the grains are not adherent (to any appreciable extent), with very fine material the adhesion may be large. It derives from three sources. If the surface is exposed to air, surface tension may act as a skin to hold the mass together. This is tremendously effective in partially dried clays. Secondly, if the material is chemically (or more correctly speaking, electrically) active, cohesion may be developed between particles of, say, one-ten-thousandth of an inch diameter. Thirdly, the interstitial water (some of which is "adorbed" or chemically bound to the grains) only moves through the material with difficulty because of viscosity in very narrow passages. This energy of suspension may be measured by an agitation apparatus.

An important factor in dredging is the stability of newly cut slopes. The degree to which the vertical sides of a cut will subside obviously determines the amount of re-dredging which may need to be done to provide a clear bottom, and in some cases the amount of lateral subsidence is embarrassingly great. Soil mechanics has specially studied this problem of subsidence. In coarse material the absence of surface tension promotes lateral slipping in wholly submerged banks, whereas these same banks can stand up to quite steep slopes above water. In finer materials the differences between above and under water conditions are less marked, but are still noticeable. Comparatively small currents greatly modify "angles of repose," especially in fine sands.

Erosion and accretion indirectly involve problems which are related to soil mechanics. Erosion is obviously facilitated by instability of slopes, and accretion is facilitated by cohesion of material. There is an interesting "hysteresis" effect in beds subject to periodically changing tidal flow. Whereas the amount of material eroded varies as perhaps the fifth power of the velocity, such erosion will continue when the velocity is diminishing below the value for the velocity at which there would be no erosion if the velocity were increasing. In other words, it requires less velocity to continue an erosion than to start it. This leads to some unexpected results, since it may often happen that erosion will *not* occur at an anticipated value for the velocity, and then a slight increase in velocity will cause an unexpected large effect. This may perhaps be called a "stiction" effect. Similarly, there may be no effective accretion at a velocity which would be expected to permit it and great accretion at a slightly less velocity. These are rather hydraulic phenomena rather than mechanical, but are closely related thereto. Fenwick has emphasised these "marginal" effects, which are often overlooked and may be very disconcerting to the practical engineer.

Sufficient has been said to indicate to those interested in dredging that soil mechanics has something to offer them. Many of the problems are inter-related. Thus the clearing of the hopper loads, whether by dumping or pumping, is obviously related to the stability of submarine banks, and the arching of such loads over the hopper door openings is related to the development in materials of cohesion within themselves and adhesion to the hopper walls.

International Congress for Harbour Engineering.

The Flemish Society of Engineers (Vlaamse Ingenieursvereniging) announces that an International Congress for Harbour Engineering is to be held in Antwerp from June 16th to 19th. Delegates from engineering societies in Belgium and in several other countries are being invited to the Congress, which will discuss matters concerned with civil engineering work on harbours, harbour machinery, handling and stocking perishable goods, and safety in harbours. Further information about the Congress can be obtained from the Secretary General, V.I.V., Torengebouw, VIII, Schoenmarkt 31, Antwerp.

Inland Waterways of the United Kingdom

The Effect of the Transport Act, 1947

By W. L. IVES, LL.B., Barrister-at-law, A.M.Inst.T.*

At the conclusion of the first year of public ownership it is not inappropriate to look back over the events of that period, to take stock of the present position, and to say a few words about the future. As far as Inland Waterways are concerned the Transport Act 1947 offers wide possibilities, perhaps greater than in the case of any other form of transport under the control of the Commission.

The difficulties which have confronted Inland Waterways in the past are well known. They were split up into a number of relatively small and un-co-ordinated units. Some co-operation, it is true, had been secured under the stress of war by the establishment by the Ministry of Transport of the Central and Regional Canal Committees, but this though valuable, was of limited scope.

The "Battle of the Gauge," which in the case of Railways was fought out before Parliamentary Committees, and settled about 100 years ago, had no counterpart as far as the Waterways were concerned, with the result that interchange of craft was very restricted. The effect of rail and road competition had led to a general decline of traffic which could only have been arrested by improved standards of service, to provide which the necessary financial resources were in most cases lacking. Considerable lengths of waterway had ceased to be used, and even where waterways carried substantial traffics arrears of maintenance had accumulated during six years of war, which reduced carrying capacity. There were, however, sufficient progressive undertakings to show that, given the necessary initiative, inland waterways could still play an important part in the economic life of the community, but it was clear that in order to find a solution of the problems besetting the industry some radical step was necessary. This step was taken by the Transport Act.

In the first place, the Act establishes unified direction, a measure which had long been advocated. Secondly, it enables the waterways to be integrated in the general transport system, and lastly, with the resources of the British Transport Commission available, it will be possible to improve the standard of maintenance, and to carry out much needed improvements.

The instrument created by the Act for putting into effect the policy of the Commission is the Docks and Inland Waterways Executive. It came into existence on 3rd November, 1947.

Powers of Executive

The Executive derives its powers from a Scheme of Delegation made under Section 5 of the Act. In addition to functions so delegated the Commission have invited the Executive to advise them as to the desirability, or otherwise, of exercising their powers under the Sections of the Act relating to the licensing of Canal Carriers, the acquisition of such Carriers' undertakings, and the abandonment of Canals.

The administration of inland waterways is only one of the functions of the Executive. The other concerns the Docks, but that side of the Executive does not come within the limits of this paper.

Members of Executive

The Executive consists of seven Members, four being full time and three part-time. They are as follows:—

- **Sir Reginald Hill** (Chairman), previously Deputy Secretary to the Ministry of Transport and Chairman of the Central Transport Committee.
- **Sir Robert Letch** (Deputy Chairman), previously Assistant General Manager of the Port of London Authority and Chairman of the National Association of Port Employers.
- **Mr. Robert Davidson,** previously General Manager and Engineer of the Leeds and Liverpool Canal Company, and Manager of Canal Transport, Ltd.

*Paper (slightly abridged) read before the Institute of Transport and reproduced by kind permission.

Inland Waterways of the United Kingdom—continued

Mr. John Donovan, previously National Secretary of the Docks Group, Transport and General Workers' Union.

Mr. George Cadbury (part-time), previously Chairman, Severn Carrying Company, and Past President of the National Association of Canal Carriers.

Sir Hector McNeill (part-time), Lord Provost of Glasgow and at one time Regional Port Director for Scotland.

Sir Ernest Murrant (part-time), Past President of the Chamber of Shipping of the United Kingdom and Chairman of the General Council of British Shipping.

The Executive is collectively responsible to the Commission, but within the organisation of the Executive itself the full time Members are responsible for particular aspects of the Executive's work under a functional distribution of duties.

Undertakings under Control of Executive

On 1st January, 1948 there passed to the Commission, and from them to the Executive some eighteen canal and inland navigational undertakings. The undertakings were those which had been under Government control, but the Bridgwater Canal was excluded on account of its connection with the Manchester Ship Canal. The Thames Conservancy and a few relatively unimportant Canals retained their separate existence, as did also certain navigational authorities having jurisdiction over tidal waters, which could, if necessary, be dealt with by schemes under Section 66 of the Act.

It was not possible to transfer the former Railway-owned canals to the Executive at the same time, as further consideration had to be given to the position of the staff, and to matters of organisation.

Transitional Organisation

The first step was to establish an organisation, and as a transitional measure the waterways which came under the control of the Executive on 1st January, 1948 were organised in five areas, each under the direction of an Area Waterways Manager.

The undertakings retained their separate identity, and each was placed under the control of a Local Manager responsible to the Area Manager.

Under the provisions of Section 118 of the Act the Lee Navigation was carried on by the Lee Conservancy Catchment Board as agents for the Commission. This arrangement was terminated on 12th April, 1948, and the Navigation was then taken over by the Executive and added to the Southern Area.

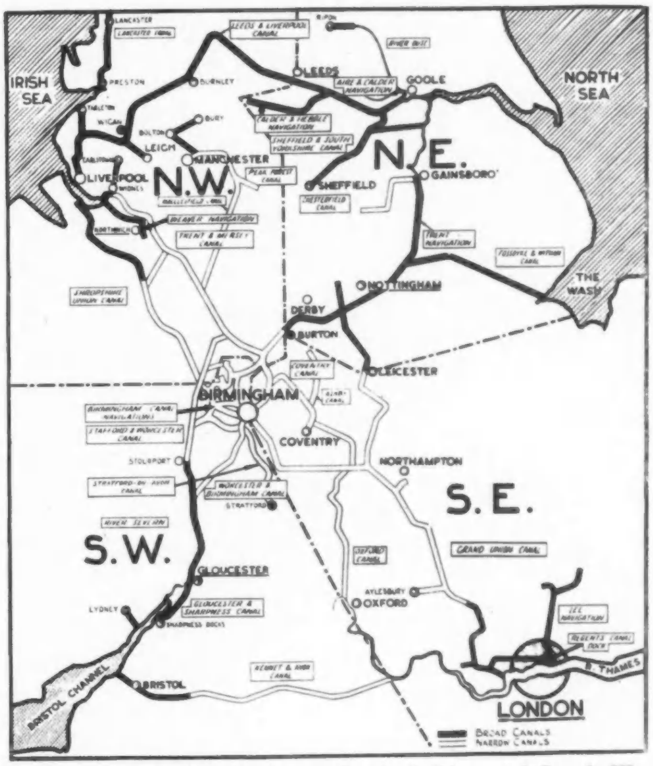
The Caledonian and Crinan Canals which had previously been vested in the Ministry of Transport, were on 1st April transferred to the Commission, who delegated their responsibilities to the Executive. It was decided not to bring them into any Waterways Area; and owing to their geographically isolated situation they have remained under separate Engineers and Managers directly responsible to the Executive.

Subsequent Re-organisation

The above arrangements were intended to be of a purely temporary character pending the integration of the individual undertakings, and on 24th May it was possible to proceed with a further stage of reorganisation. The five operating groups were reduced to four Divisions, exclusive of Scotland, each of which was based on a major estuary and port system. The separate organisations inherited from the previous owners ceased to exist, and within each Division the administration was unified under a Divisional Waterways Officer responsible to the Executive at a Divisional Headquarters, Divisional Engineers, Accountants, Traffic Officers and Estate Officers were also appointed with branch offices as required.

The new Divisions, shown on the accompanying plan, are as follows :—

North Eastern Division Comprising the former Aire & Calder (with Goole Docks), Calder & Hebble, Sheffield & South Yorkshire and Trent Navigations, also the section of the former Grand Union Canal north of Leicester.
Headquarters—Leeds.



North Western Division Comprising the former Leeds & Liverpool Canal, Weaver Navigation (including Weston Point Dock) and the Staffordshire & Worcestershire Canal north of Autherley.
Headquarters—Northwick (temporarily).

South Western Division Comprising the former Sharpness & Gloucester Canal (including Sharpness & Gloucester Docks), Severn Navigation, Worcester & Birmingham Canal, Staffordshire & Worcestershire Canal south of Autherley, Birmingham Canal Navigations west of Birmingham and the Stourbridge Canal.
Headquarters—Gloucester.

South Eastern Division Comprising the former Grand Union Canal (including Regents Park Canal Dock) but excluding portion north of Leicester, Birmingham Canal Navigations east of Birmingham, and the Oxford, Coventry and Lee and Stort Navigations.
Headquarters—Ruislip (temporarily).

The Divisional Waterways Officers were given the fullest measure of local responsibility and the widest scope for initiative and decision.

Substantial economies were effected as a result of the re-organisation, and it is expected that further savings will accrue as the introduction of new methods proceeds.

A system of bulk purchase of stores has since been instituted, with satisfactory results.

Transfer of Railway Canals

The transfer of the railway canals has proceeded by stages, and the following waterways have now been included in the Divisions indicated :—

North Eastern Division
Chesterfield Canal
Cromford Canal
Trent and Mersey (part)

South Eastern Division
Ashby

North Western Division
Ashton Canal
Huddersfield Narrow Canal
Lancaster Canal
Macclesfield Canal
Manchester, Bolton & Bury
Peak Forest Canal
Shropshire Union Canal
St. Helens Canal
Trent & Mersey Canal (part)

Inland Waterways of the United Kingdom—*continued*

Other canals are in course of transfer, and the process will shortly be completed.

Carrying Activities

Hitherto canal undertakers have not, generally speaking, acted as Carriers, but there were some exceptions, namely, the Aire and Calder and Trent Navigations, which performed these activities on their own account, and the Grand Union Canal Company, who had control of the Grand Union Carrying Company and the Erewash Carrying Company. These activities passed to the Executive with the control of the undertakings.

The Executive have considerably extended these operations. They have acquired a 100% holding in Canal Transport Limited, a Company operating on the Leeds and Liverpool Canal. They have also purchased the general merchandise fleet of the Severn Carrying Company, and more recently the craft and principal depots of Fellows, Morton & Clayton, Ltd., one of the oldest Carriers, with extensive business on the London to Birmingham route, in the Midlands and on the connections with the Mersey.

The Executive now own, or control, some 1,100 carrying craft, or about one-sixth of the total fleet operating on the Canals, and they are represented on all the main inland waterway routes.

Much has been done in the repair and modernisation of craft, and the degree of serviceability is higher than a year ago.

Warehousing

This is an important branch of the activities of the Executive, and with the acquisition of carrying undertakings, the responsibilities have increased. They have recently taken over from the Ministry of Transport the large transit sheds at Worcester and Stourport, which were constructed during the War.

The Inland Waterway Carriers

The Act did not provide for the compulsory acquisition by the Commission of the undertaking of the independent Canal Carriers, but authorised the Commission to introduce a system of licensing of Carriers on any part of their inland waterways. No steps have yet been taken by the Executive in this connection, but discussions have been initiated with the National Association of Inland Waterway Carriers on subjects of common interest. The Association have appointed sub-Committees to confer with the Executive on various matters of mutual concern.

Re-establishment of Central and Local Conferences

One result of the discussions with the Carriers has been the re-establishment of the Central and Local Canal Conferences which had fallen into abeyance since the beginning of the War. The Agreement, dated 31st October, 1948, between the Executive, the Railway Executive, the Road Transport Executive and the National Association of Inland Waterway Carriers, provides that the Conferences shall consist of representatives of the parties with functions including the scheduling of rates for traffic in which the Executive and the Carriers have a common interest with the Railway Executive and the Road Transport Executive. Such rates are not to be varied without the consent of the Conference.

Where similar services are rendered by rail, road or waterway, rates for conveyance by inland waterway are normally to be lower than those for rail and road.

The Central Conference has already been set up, and the Local Conferences are in process of being constituted. This is a measure of practical co-operation which augers well for the future.

Co-ordination with other Executives

Contacts have been established at all levels with the Officers of other Executives. In the North Eastern Division arrangements have been made with the Railway Executive for the mutual hiring of vehicles. In other Divisions the Road Transport Executive are undertaking collection and delivery services hitherto performed by the Executive or their subsidiaries. Arrangements of this nature have distinct possibilities and they will be extended as time goes on.

Works and Improvements to Inland Waterways

As previously mentioned considerable arrears of dredging and maintenance works generally had accumulated during the War, and this was one of the first problems which confronted the Executive. Instructions were accordingly given for the necessary measures to be put in hand to increase the capacity of the Waterways so as to enable craft to carry full loads, and this work has been greatly facilitated by the ability of the Executive to switch plant and appliances to points where they are most needed. The transfer of maintenance craft is restricted to some extent owing to the varying gauge of the waterways, but even taking such limitations into account, a substantial degree of benefit has been secured.

Owing to the necessity for observing economy in labour and materials it has not been possible for the Executive to carry out many major schemes. Among those authorised were improvement to the River Severn at an estimated cost of £35,000, and repairs to walling on the Lee Navigation at a cost of approximately £38,000. Various proposals for capital works are under examination which can be started if they are found to be justified and circumstances permit.

The Executive have several waterways which are no longer used for commercial purposes, including some which have been closed for traffic under private Acts. Many of these pass through pleasant scenery in rural parts of the country, and a survey is being undertaken to see what steps can be taken to increase the facilities for boating and tourist services.

Tolls and Charges

Much preparatory work has been done in connection with the Charges Scheme required by Part V of the Act, and this is still proceeding. In the meantime the Executive have been able to commence the introduction of through tolls, a measure of simplification which was long overdue. The process is practically complete within each Division, and it should now be possible to pass to the next stage of consolidating the inter-Divisional tolls.

Staff

In the field of staff relations the Act has much to offer. It has created many opportunities for the staff, besides placing increased responsibilities upon them. One of the disadvantages inherent in the former system was the lack of mobility. With the passing of the separate undertakings the obstacles to the free interchange of staff have been removed, and this should enable them to acquire wider knowledge and experience and broaden their outlook.

The conditions of employment for the clerical and supervisory staffs differ widely. Some degree of uniformity is clearly desirable, and this is one of the matters to which attention is now being given. Schemes for the training and education of staff are also under examination.

The negotiating machinery for the industry has been reviewed in collaboration with the Trade Unions, and the independent Carriers, and the Constitution of the Joint Industrial Council has been revised so as to bring the procedure into line with more recent industrial practice.

Compliance with the provisions of the Education Act 1944 with regard to the education of the children of canal boatmen has always been a matter of difficulty, and arrangements are therefore being made for the provision of a residential hostel at Birmingham by the local Education Authority with the assistance of the Ministry of Education. If this is successful it should lead to the establishment of others.

Technical Research

This is a matter which has hitherto received insufficient attention in this country, so far as inland waterways are concerned.

On the Continent of Europe and in America the situation is entirely different. In Germany alone there were twelve hydraulic laboratories, in Italy five, in France three and elsewhere on the Continent about eight. In America there are five. It has been recorded that the whole cost of the construction of the Karlsruhe Hydraulic Laboratory, one of the largest and best known on the Continent, has been saved many times over by reductions in construction costs resulting from hydraulic investigations carried out on behalf of clients.

Some of the subjects which suggest themselves for investigation are the design of channels, weirs, sluices, etc., shape of craft,

Inland Waterways of the United Kingdom—continued

destruction of weed growth, prevention of ice formation in locks, protection of banks against erosion, most efficient type of mechanical propulsion for inland waterway craft and methods of ascertaining source of leakage.

The Executive and the Commission are giving close attention to the methods by which research should be conducted, and it is clear that there are great possibilities in this field.

The Present Position

The Executive have now under their control, or will shortly do so when the transfer of the Railway Canals is completed, some 2,050 miles of waterways. Of these approximately 1,000 miles are broad waterways, which consist largely of canalised rivers and link the ports in the estuaries with inland towns, and the remainder represent narrow channels mainly in the interior which can be used only by boats of 7-ft. with a carrying capacity of about 30 tons.

The much larger unit loads possible on the broad waterways enable goods to be off-loaded overside from sea-going ships to lighters or barges, which can proceed direct to inland destinations.

The narrow canals do not enjoy these advantages, although in common with the wide waterways they are eminently suitable for the conveyance of goods of a bulky or fragile nature, where the time occupied in transit is not such an important factor. The services they offer are more directly competitive with other forms of transport, and their ability to hold and secure increased traffic depends upon the quotation of favourable rates, a principle which is recognised by the Conference arrangements already referred to.

The withdrawal of the Government subsidy, coupled with the increase of tolls which operated from 1st December, 1947, has created many problems for the Carriers who have at the same time been faced with additional costs. The Executive have endeavoured to mitigate the consequences where traffic would otherwise be lost, but no ultimate solution can be attempted pending the submission of the new Charges Scheme.

Nevertheless in spite of these difficulties it is satisfactory to record that traffic showed an increase of over 1,000,000 tons during the year, as appears from the following table :—

Statistics for 52 weeks ended 26th December 1948 (including Railway Canals)

		Coal, Coke etc.	Liquids in Bulk	General	Total
Originating	1947	4,830,000	1,664,000	3,602,000	10,096,000
Tons	1948	5,469,000	1,739,000	3,913,000	11,121,000
Net Ton	1947	68,841,000	33,413,000	74,158,000	176,412,000
Miles	1948	79,271,000	37,387,000	76,291,000	192,949,000

Future Problems

It is evident that existing shortages of labour and materials will continue for some time, and that the opportunity for the execution of major schemes will be limited. Until the situation improves work must be largely confined to improving the standard of maintenance, and to other cases where proved economic justification exists. The use of powered craft has increased the need for bank protection; locks require reconstruction; handling appliances need to be moderised and improved; additional storage accommodation provided, and craft require renewal. There is clearly a wide field of opportunity in this direction.

In the meantime the examination of new projects must proceed. Consultation will be required with planning authorities in connection with the preparation of development plans under the Town and Country Planning Act 1947, and by a wise use of the machinery established by that Act industries depending on water transport for raw materials, fuel and the despatch of manufactured products should be attracted. Many large electricity stations are being built, which will require not only water for cooling purposes, but will involve the carrying of large quantities of coal. The Executive have considerably strengthened the commercial organisation, and this should ensure that they are fully acquainted with the requirements of individual traders, and that no traffic possibilities are overlooked. An officer has been appointed with the object of making known the facilities which the Executive are able to offer.

Much remains to be done. The neglect of the last 100 years cannot be made good at once. What is required, above all, is the infusion of a new spirit of enterprise in the industry, which has too often been regarded as the " poor relation " by other forms of transport, the creation of fresh standards of public service, and a recognition by all engaged in the industry of the part which they have to play in the unified transport system. There are already signs of a growing awareness of these considerations, which it must be the task of the Executive to foster and promote.

On the part of traders and the general public, considerable interest is being displayed in the new organisation, and there is a demand for the provision of better facilities which must be met.

The Evolution of Marine Radar

By Lt. Cdr. D. H. MACMILLAN, R.N.R. (Rtd.); Assoc. I.N.A. (M.I.N.).

As announced in the March issue of this Journal, a most interesting symposium of lectures on all aspects of Navigational Radar, under the auspices of the Institute of Navigation, was given at the Royal Geographical Society's Lecture Hall, Kensington, on 18th February last, and the following is a constructive commentary on the meeting.

Practically every aspect of ship and shore-based radar was ventilated and vigorously but constructively criticised by a very representative group of lecturers and audience under the chairmanship of Sir Robert Watson Watt, who, as usual, displays his genius for handling all situations by the *bon mot* appropriate to the occasion.

Ship-based radar is certainly cutting its teeth, but that it is a healthy and persistent child of promise cannot now be doubted.

As a navigator, I found the Ministry statistics in the well constructed lecture by Messrs. Parker and Le Page very illuminating, even if the enthusiasm displayed (in some cases) appeared to be somewhat undue in the present state of the art.

In 1947 and 1948, 45 and 40 U.K. ships respectively were involved in collisions which clearly might not have happened if they had been fitted with radar. Similarly, nearly 50 strandings per annum during the same two years might also have been averted if the same precaution had been taken.

The rescue of all the crew off the Norwegian " Veni " by " Weather Recorder " of Islay in January, 1948, was affected almost entirely by radar.

Time saving through closer adherence to courses, reduced cautionary clearances, avoidance of delay in closing light vessels and other seamarks and reconnaissance of channels prior to entry, could not be doubted, and it was inferred from statistics that the fitting of the entire British Merchant Navy Fleet by suitable radar equipment, adequately maintained, would save some £2 million a year.

During the four-day fog (November 27th to December 1st, 1948) in the Port of London, 120 ships were anchored at one period, and the cost of such was estimated at £17,000 per day from running costs *alone*, which were only a fraction of the total economic loss through time lost by outward bound ships.

Whilst the Ministry welcomed further data bearing on these points, a curious law had been deduced from the statistics, namely, that the cost of delay varied directly as the square of the number of days of continuous delay:

i.e.: Four days continuous delay was equivalent to sixteen single day delays.

Over 400 British merchant vessels are now fitted with radar, and this is being done at the rate of one ship per day, over 44% of cargo and passenger liners being now equipped.

Amongst other interesting diagrams, a chart was displayed showing the comparative incidence of bad visibility on an annual basis for the British Isles.

Such clearly shows the necessity for the separate and special consideration of areas such as the Humber, Liverpool and Southampton districts when considering specifications for harbour supervision radar.

The Evolution of Marine Radar—*continued*

As Sir Robert had pointed out in his opening remarks, radar was in a state of evolution and development. There were no operational text books, and techniques were growing under the stimulus of experience, discussion and often constructive controversy.

A ship is certainly not the most suitable site for a radar set, but a number of the papers dealt with technical details of fitting and using constructively the existing marine radar equipment. It was clear that the nautical users were more interested in the broad principles of development affecting their actual requirements, and at question times speakers raised the following points:

(a) Close quarter accuracy within 300 yards is uncertain and the radar engineer should concentrate on this problem.

(b) The interpretation of the radar plot in terms of the navigator's psychology and training has yet to be achieved and existing chart matching devices, etc., must yet give way (through scientific research) to a more "obvious" presentation of the required data.

(c) Some very comprehensive and reliable monitoring system is imperative to enable a navigator to know at once when optimum performance is not available to him.

(d) It was felt that development of radar would be expedited by a committee of navigators and scientists working as a team rather than the present system of constructing sets to please individual users alone, however well done by the manufacturers.

(e) Representative navigators should state clearly their "staff-requirement" and radar scientists, engineers, technicians and designers should make this their target.

(f) A suggestion by one lecturer that in view of the advances of radar the Rule of the Road regulations for preventing collisions should now be relaxed was not favourably received by the navigators present as it appeared quite remote from the canons of navigation and pilotage which cannot be discarded on the evidence of an "aid" alone. A buoy is a very useful and venerable "aid," but even this, as a floating mark, cannot be relied upon alone in prudent navigation.

(g) Research on the detection of ice by radar is not yet in a satisfactory state, growlers often being seen on the scan when bergs 20-30-ft. high do not paint at all.

(h) The servicing of radar sets should be done by trained personnel, not necessarily navigators, as the majority of failures are due to valves, fuses, electrical connections, etc., and a trained rating allocated to the navigator for such a duty would greatly increase reliability of performance.

In the paper by Lt. Satow, R.N., the possibilities of an accurate plot using a 12-in. P.P.I., and chart matching on bold coastlines, or salient radar reflector systems, was described. Clearly the "own ship" problem of position can be solved in this way if more modern devices for easy matching, transfer and presentation in the chart room are available—and they are, of course possible—but the lecturer made the very interesting point that the positions of salient objects *inland* was now a necessary factor especially where coastlines were low and unrelieved.

This raises an interesting problem for the hydrographic surveyor who must now start to present inland topography in greater detail than hitherto, certainly in harbour and estuarine approach charts.

Whilst comparisons are odious and a good time was had by all, I think the ship-based radar lectures were most suitably concluded with a remarkable lecture by Captain Wylie, R.N., which won the approval and admiration of his fellow seamen and navigators who felt that here was someone who was giving lucid expression to their deepest instincts on the question of this new aid which has now arisen so definitely above the horizon as to shake off the initial disturbance caused by its first arrival and release for peace-time navigation.

Practically every question raised was dealt with by this lecturer, whose paper in full should be read by all navigators and scientists desirous of gaining a true view of the perspective required for real progress in radar development.

He pointed out that the present P.P.I. presentation to the mariner was tantamount to expecting him to handle his ships, from a bird's-eye view, at a considerable altitude and in two dimensions only, which could not achieve final satisfaction.

Until a new form of presentation was provided giving a larger scale plot and a three-dimensional sense, two-thirds of the natural sense of handling ingrained by the sub-consciously absorbed tradition training and experience of sea officers would be denied to them.

Captain Wylie also suggested P.P.I. photographs for comparison as an alternative to Chart Comparison units. I suggest that Captain Wylie's paper be circulated as a pamphlet by the Institute, containing perhaps the most valuable modern appreciation of nautical psychology relevant to our present problem of radar development at sea.

In concluding a commentary on ship-based radar, one cannot avoid mentioning an aspect dealt with by several lecturers namely, the time and worry-saving aspects of radar.

There is no doubt that if the mariner is allowed to apply radar within the traditional framework of his ancient (and even eternal) cautionary procedures, time and worry *will* be saved and he will gain the confidence in clear weather which will provide the basis for sound technique in the use of this aid in poor visibility.

The M.O.T. lecturers rightly showed the connection between the physical and psychological well-being of the responsible seaman, and his efficiency. It is undoubtedly a fact that the unrelieved and continuous nervous tension inseparable from the navigation of large and fast ships running to modern North Atlantic schedules (for example) has been the cause of illness and even premature death of officers on good medical testimony supported by psychological research.

Radar, rightly developed and used as an aid proper, when it has inspired the confidence of the navigator (as it undoubtedly will, in due season with research), must lessen this psychological stress.

Yet if the navigator is to be pressed against his nautical instincts and training to achieve speed in fog, even by the example of daring and injudicious spirits in peace-time, he will rebel and rightly reject this pressure as a virtual yoke which in some cases, and under other circumstances, his fathers were unable to bear.

It is clear that a suitable committee of scientifically trained and practical sea and air navigators must be allowed to properly and formally state their "staff requirements" and ultimate aims to a collaborating group of radar scientists and engineers.

Only thus will true progress be made by means of those modern scientific resources to which no seamen's requirement should now be impossible.

In such a venture, which should be unfettered either by commercial interests or too much Governmental supervision, the Ministry of Transport and Admiralty would greatly profit in commending radar to merchant ships.

Shore-based radar was adequately dealt with by Commanders Colbeck and Price, whose achievements are too solid and well known to need comment. The operational techniques devised for the difficult Mersey area, reflect credit on all the officers concerned with them.

It should again, I think, be reiterated that each port installation must be considered on its own merits and it is a tribute to the manufacturing firms that they have met the needs of Liverpool so fully.

One would like to have heard more of the use of modified (shore-based) marine radar sets such as have made history in Douglas, I.O.M., as undoubtedly these must have their place perhaps in the greater ports where good visibility prevails over the greater part of the year, and coverage over congested areas is desirable.

In concluding these observations there seems to be no doubt that the Institute of Navigation and its collaborators have focussed attention on the present state of evolving radar techniques in such a manner as to mark a very definite milestone in the progress of this new science.

Compression Tests on Docking Blocks

Extracts from a report carried out at Brisbane Graving Dock, Cairncross, by Stanley River Works Board

By E. M. SHEPHERD, M.E., A.M.I.C.E., A.M.I.E.E. (Aust.).

SUMMARY.

COMPRESSION tests were carried out on two complete stacks of docking blocks as used in the Brisbane Graving Dock at Cairncross and also on large specimens of hardwood and pine loaded perpendicular to the grain as in docking practice, the objects being to determine the strength of the blocks and the capacity of their Queensland pine caps to support heavy ships.

In the tests on full scale docking blocks, the ultimate strength was found to be over **180** tons per square foot of loaded area, when the load was applied over a central eighteen inch length of the blocks. The ultimate strength for uniform loading over the full length could not be determined with available equipment, but should exceed **600** tons. Sustained loading much over **300** tons per block would, however, be highly undesirable, as it might be accompanied by appreciable creep in the timbers, and, perhaps, local cracking, and might eventually become unsafe.

Load deflection curves for the complete docking blocks were also obtained.

The results of the tests confirm that all ships which can enter the dock, including ships with concentration of loading up to **80** tons per foot run, such as fleet carriers, can be safely docked on the available blocks when these are suitably arranged, and that the use of capping pieces of Queensland pine on the blocks is safe for these conditions. This timber, when overloaded, yields without disintegration, a valuable property in preventing local overloading.

1.—Objects of Tests.

The objects of the tests were to investigate:

(a) the strength and behaviour of the **4-in.** thick Queensland pine capping pieces forming the upper member of the docking block assemblies, as used in Cairncross Dock, when subject to heavy loading, particularly such as might occur under the after cut up or knuckle of a ship; and

(b) the general behaviour of the stack of blocks,

so as to be able to compare the behaviour of pine and hardwood capping pieces and also to estimate the maximum safe loadings and deflections.

This involved an investigation of the elastic and plastic behaviour of a complete stack of the blocks and of selected samples of timber under such ranges of loading as were obtainable from the **1,000,000** lb. Amsler compression testing machine in the University of Queensland Engineering Laboratory. The investigation was made during August and September, **1945**, as opportunity presented itself.

2.—General Notes on Docking Blocks.

Ships in dry dock are supported on one or more rows of docking blocks. These blocks have to support the dead weight of the ship, and generally by far the greater portion of it is carried on the central line or keel blocks. It is the general practice in Australia to use hardwood blocks, but overseas special blocks of cast-iron and even cast-steel are frequently used.

Even when iron or steel components are used in docking blocks, the upper member or cap, which is in contact with the ship's bottom, is invariably of timber, but practice varies as to the type of timber used. It is general practice to use a soft wood for small ships but, in overseas practice, hardwood is usual for the cap when very heavy ships are docked, and the usual British Admiralty requirements are that "soft wood" caps should not be used for docking heavy cruisers and larger ships.

The U.S. Navy Docking Manual states: "The use of Douglas fir for cap blocks appears to be of particular advantage, especially in the case of destroyers . . . The characteristic of the wood appears to be such that it is capable of taking the usual docking load, but when loaded excessively, the wood compresses easily and allows the load to be distributed over the adjacent blocks. It was found on tests at the Philadelphia Navy Yard, where a destroyer was docked on hard cap blocks, that the pressure at individual keel blocks may be as high as four times the mean pressure per block as calculated from total weight and total block area . . . The use of Douglas fir cap blocks is recommended for docking destroyers, especially where they are being docked on composite blocks. Cruisers may be docked on either hard or soft cap blocks, but in either case the same type of cap block should be used throughout. Hard cap blocks are recommended for docking all battleships".

In Australia, except in the case of the Captain Cook Dock, where all blocks are hardwood, caps of hoop pine have been generally used for large ships, apparently with complete success, but it is clear from the comments of the Admiralty, the U.S. Navy Docking Manual and technical literature, that there may be some serious disadvantage in the use of softwood caps on docking blocks when heavy ships are docked.

In answer to this, it has been claimed that hoop pine is much tougher than the overseas softwoods; and that overseas "hardwoods," such as elm, which is the favoured material for caps, are generally much weaker than Australian hardwoods. Unfortunately, we have no figures available for the strength of elm in compression perpendicular to the grain, but available data indicates that English elm (Ulmis procera) is generally weaker than hoop pine in all properties.

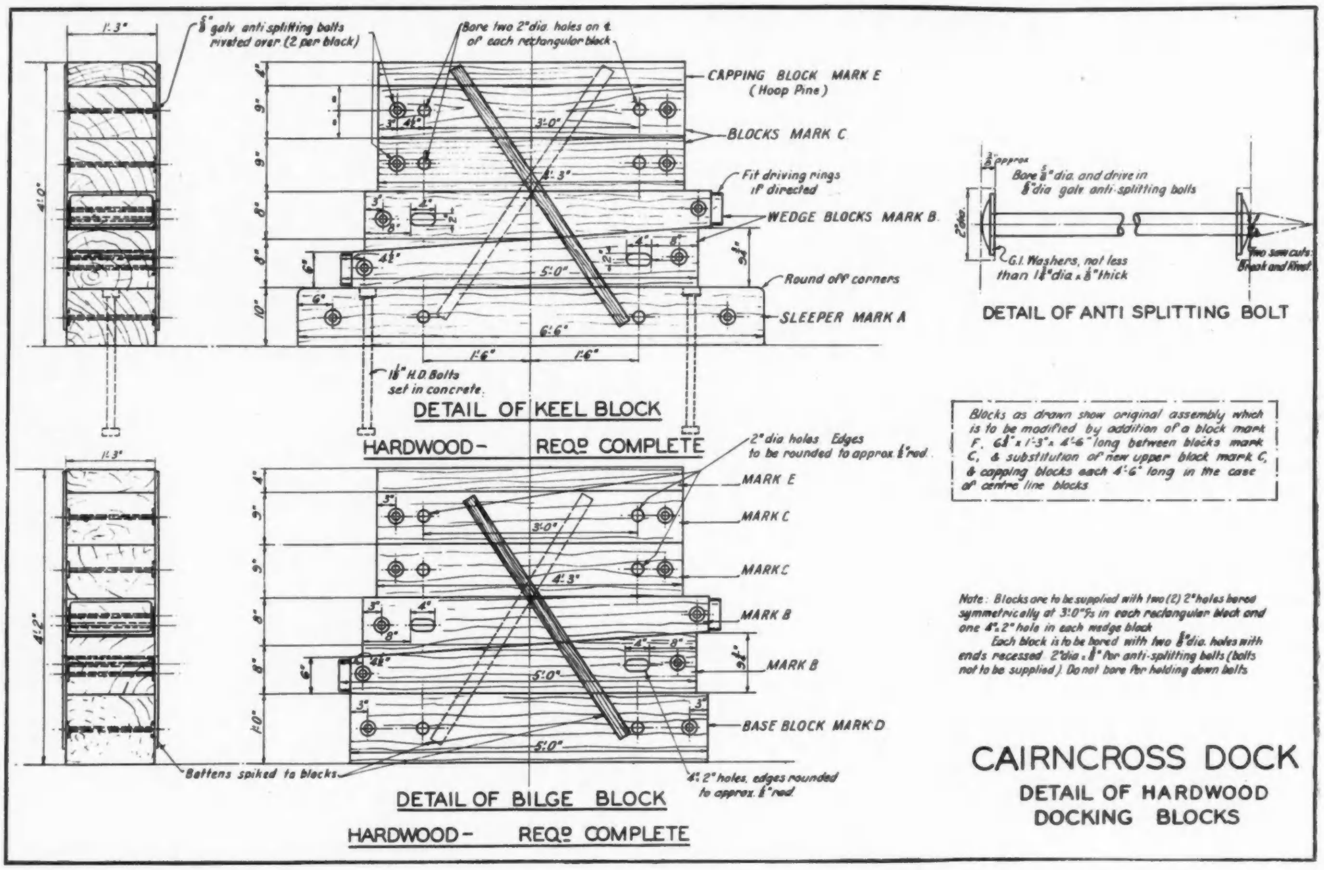
During docking down, however, certain blocks may be obliged to carry a far heavier load than will be their share when the dock is dry and the ship fully supported on blocks, and this applies particularly to the case when a vessel with considerable difference of draft fore and aft has to be docked. In the case of a vessel with greater draft at the stern, the first part of the ship to rest on the blocks will be the after cut up. Moreover, if the keel block under the after cut up were completely unyielding, it would have to support a load equal to the whole force which, applied upward at this point, would be required to bring the ship to an even keel, which force may be hundreds of tons in a big ship. Actually, there is an appreciable yield in the loaded blocks, and hence the load is shared with adjacent ones.

The extent to which the load is spread will depend on the elastic and plastic deformation of the stack of blocks and the cap. Methods of calculating this are given in publications, e.g., the "U.S. Navy Notes on the Dry Docking of Ships". Moreover, at the after cut-up, the width of keel may only be a fraction of the width of the capping piece, thus causing a load much more concentrated and of greater intensity at the central part of the cap. For example, in one ship docked in Cairncross Dock, the knuckle width was about **18-in.** wide on the flat, and the cap after docking showed the effect of considerable compression.

3.—Description of Docking Blocks at Cairncross Dock.

The original design of the docking blocks at Cairncross Dock is shown on the accompanying plan, the blocks consisting of a stack of hardwood members and a hoop pine capping piece, **15-in.** wide, with an effective length of **4-ft. 3-in.** and height of **4-ft.** The lower member or sleeper in the case of the centre line blocks is **15-in.** x **10-in.** x **6-ft. 6-in.** bolted to the concrete, and the corresponding member for bilge blocks is **15-in.** x **12-in.** x **5-ft.** long.

Compression Tests on Docking Blocks—continued



On these base blocks are the two hardwood wedge blocks, then two hardwood blocks, each 15-in. x 9-in. x 4-ft. 3-in. long. The base blocks, wedges and the 9-in. blocks were originally all of iron-bark. At the request of the Admiralty, however, it was arranged to modify the stacks by raising their height to 4-ft. 6-in. and increasing their length to 4-ft. 6-in. by the addition of new hardwood blocks 15-in. x $6\frac{3}{4}$-in. x 4-ft. 6-in. long and new caps 4-ft. 6-in. long, these changes being designed to suit the height required for the "Asdic" fittings and the width between the double keels respectively of some warships.

The new blocks, 15-in. x $6\frac{3}{4}$-in. x 4-ft. 6-in. long, are to be placed immediately under the caps, and thus overhang the one below by $1\frac{1}{2}$-in. each. They are partly iron-bark, partly spotted gum, forest red gum (locally called blue gum) and grey gum. These timbers are available, but to date of writing there has been no occasion to fit them.

In the tests carried out, a 15-in. x 12-in. x 5-ft. base block was used, since a 6-ft. 6-in. block would have been inconveniently long, and the stack really represented a bilge block assembly instead of a keel block. It is not thought that this could have any appreciable effect on the interpretation of results.

4.—Programme of Tests.

The tests may fall into two series, viz.:—

(a) Compression tests on a complete block stack with different caps, the load being applied over part only of the cap to represent the conditions under the after cut up of a ship during docking down. A stack of less than average quality was selected for test, so that results obtained would be conservative.

(b) Compression tests on selected blocks of timber loaded perpendicular to the grain to represent capping pieces as well as hardwood block components of the stack

The first series (a) comprised five separate tests, made with four Queensland pine caps (numbered 1, 2, 4 and 5) and one hardwood cap (numbered 3). The summary of tests and results is shown in the Table opposite. The method of setting up the blocks in the Amsler testing machine is shown in Photograph A.

The summary of tests and results of the second series (b) are not reproduced here, but some comments on the results are given under "Advantages and Disadvantages of Pine Caps for Docking Blocks." The results of both series influenced the conclusions finally arrived at.

5.—Limited Scope of Tests.

The tests were not a complete scientific investigation of the strength of the timbers concerned, but merely sought to gain as much general data on the strength of large blocks when overloaded as the material and time available permitted.

For example, no attempt was made to determine the moisture content of the timbers, without knowledge of which test results cannot be correlated; nor was the rate of loading constant, which factor has considerable importance; nor was the strength relationship between the blocks as tested and small clear specimens representative of the wood in the blocks examined.

Moreover, the testing machine was designed for heavy loading, whereas many of the actual test loadings were comparatively light and near the lower limit of its range. Calibration corrections had to be applied to these, which may have been slightly in error.

As the scope of tests was therefore so limited, conclusions can be expressed only in rather general terms, and a warning must be made against accepting these conclusions as hard and fast, since they were based on only a few tests which were limited in scope and in which the materials tested may not have been truly representative.

6.—Conclusions from Tests.

(a) The tests show that the hoop pine (Araucaria cunninghamii) capping piece is capable of sustaining a load equal to the strength of the block stack without disintegration, but its

Compression Tests on Docking Blocks—continued

yield is then very great and not fully recoverable when the load is removed. Shrinkages up to 50% of the original thickness of the pine were observed, and up to half of this distortion was generally permanent.

The relationship between applied loading and yield observed during each of the tests of Series "A" is shown graphically in Figs. 2 and 3. Fig. 2 shows the yield in the 4-in. thick capping blocks only, and Fig. 3 shows the yield in the stack of blocks as a whole with the various capping pieces. Although in the tests, loading was concentrated over a section only of the capping pieces, the information obtained enabled curves to be prepared to show with reasonable accuracy the relationship between load and yield in the stack for the case of uniform loading over the whole capping piece.

The load intensity attained in docking practice will not normally reduce the thickness of the pine by more than a few per cent., and the yield under load is, in general, advantageous, as it tends to limit the increased loading on the blocks and the ship's bottom due to unforeseen factors, but it can be a disadvantage if some blocks only are subjected to abnormally heavy loading during the docking procedure and thereby undergo a permanent yield, e.g., under the after cut up, as they may not then take their correct proportion of the weight of the ship when it is completely supported on the blocks. This disadvantage is largely eliminated by correct arrangements of blocking.

Very heavy ships are generally docked on more than one line of blocks, and, when necessary, additional centre line blocks can be added between those in regular use and a cribbage used under the after cut up, which is normal practice. It is advisable that the block areas should be so arranged that the theoretical intensity of loading on the blocking, and, consequently, the load per block stack,

No. of Test	Nature of Capping Block	Density of wood in cap, lb/ cub. ft.	Nature of Stack	Area loaded	Max. load applied		Nature of Failure	Approximate Reduction of cap thickness under load of:			Reduction of stack height excl. cap for load of 100 tons	Remarks
					Kips	Tons		50 tons	100 tons	150 tons		
1	Used Qld pine 15¾"x4¼" x4'3". Previously saturated but out of water 3-4 weeks	51.1	4'0" high stack of 5 H.W. blocks. Upper blocks 4'3" long	15" central length of cap	572	257	Capping block compressed with stack undamaged. Longitudinal splitting.	.30"?	.7"	1.0"	.37"	Pine cap very tenacious. Did not show so pronounced a yield point as in the case of other caps. Recovery of strain good but only at low load - negligible recovery when unloaded to half max.
2	New Q'ld pine 15"x 4-1/32" x4'6". Dry	29.8	4'6" high stack of 6 H.W. blocks as for No.1 with additional top block 6¾"x4'6" long.	18" do.	270	121	Capping block compressed with some breaking of fibres near edge of loaded area. Stack undamaged.	.06"	1.6"	-	.35"	Cap showed very pronounced yield point with shrinkage exceeding 1". Recovery only partial.
3	Hardwood (spotted gum) 15-1/16" x4" x4'6" Dry but unseasoned	74.7	4'6" high stack of 6 H.W. blocks as for No.1 with additional top block 6¾" x4'6" long	18" central length of cap	860	384	Cap crushed & destroyed & upper block partially crushed & split. 2nd & 3rd. block split.	.055"	.07"	.08"	.30"	No pronounced yield point before complete failure.
4	New Q'ld. pine 15" x4⅛" x4'6" Dry	36.6	Stack reconditioned by replacing upper two blocks with 9"x15"x4'6" Ironbark and 6¾"x15"x4'6" spotted gum	18" do.	580	259	As for No.2	.075"	1.25"	1.85"	.31"	As for No.2
5	Slightly used Q'ld. pine 15-1/16"x 4⅛"x4'6". Soaked in water and tested wet.	42	Same stack as No.4	18" do.	800	357	Cap compressed with longitudinal split. Upper block (6¾") partially crushed & split 2nd block split Damage less than in No.3.	.26"	1.13"	1.45"	.3"	Greater yield under low valued but not so pronounced a yield point as for Nos. 2 & 4 but much more than for No.1. Cap was compressed to about 1⅞" thick under loading plate at max. load.

Compression Tests on Docking Blocks—continued

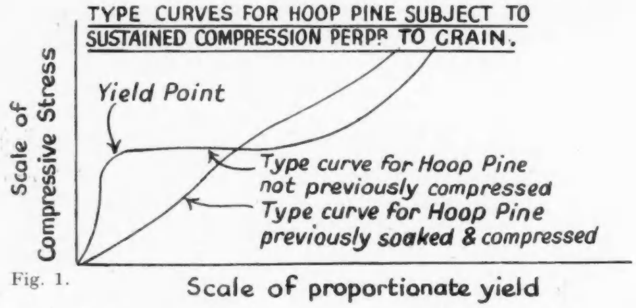
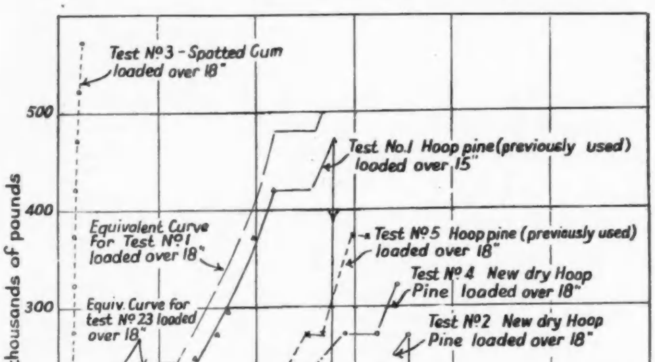


Fig. 1.

should be nearly equal under all parts of the ship—and that the average intensity of loading should not exceed about 25 tons per square foot of blocking or about 130 tons per stack. This loading need not be exceeded even in the case of ships with a maximum weight per foot run of up to 80 tons, such as fleet carriers, for the available blocking at Cairncross can be arranged to suit.

The main reason for such a limitation in allowable loading is not so much on account of strength considerations as to keep the yield in the timbers when loaded within certain limits, and, under these circumstances, too, the use of pine caps can be expected to provide more uniform loading than would hardwood, and, consequently, safer conditions, in that much greater irregularities in the ship's bottom or in block levelling will be provided for with only moderate local overloading. The use of hardwood capping blocks under these circumstances will not appreciably increase the proportion of load which a stack might have to carry by not permitting any relatively large local yield until the timbers have become over-loaded. The heaviest ships that can enter Cairncross Dock can be safely docked on blocks with hoop pine caps.

(b) Hoop pine is appreciably tougher and more resilient than Oregon pine, although both materials tend to compact without disintegration when compressed, and it is generally superior as a capping material, except perhaps when very light ships are docked. The variations in density observed were apparently greater than could be accounted for by changes in the moisture content of the pine, and it seemed that the properties of different specimens of pine vary with their relative density. Consequently, and particularly for



docking heavy ships, the densest possible pine should be selected, as denser specimens showed markedly superior behaviour.

Previously unused specimens of hoop pine and Oregon pine, whether dry or saturated, when loaded perpendicular to the grain, were found to have a yield point, corresponding to a stress above which considerable shrinkage occurred with little increase in stress. This yield point is appreciably lowered by soaking the specimen in water, but the characteristic strain-stress relationship is not appreciably changed thereby.

However, when hoop pine has been previously compressed, it appears to exhibit a quite different characteristic, in that the yield point is less pronounced and may almost disappear so that load and yield are nearly proportional, although the yield is not necessarily fully recoverable on removal of the load. The value of stress divided by proportionate yield under these circumstances is variable, but of the order of 6,000 lb. per square inch, whereas the elastic modulus value is of the order of 50,000 lb. per square inch when the stress does not exceed the limit of proportionality which is probably at about 300 lb. per square inch.

Hence new pine under light load only appears to be more resistant than old pine previously compressed. Fig. 1 illustrates the comparative behaviour of new and such used pine.

Observed yield point stresses varied from about 400 lb. per square inch to over 500 lb. per square inch with new dry hoop pine and two comparative specimens cut from the same block of timber, tested dry and wet respectively, gave figures of approximately 480 lb. per square inch dry and 380 lb. per square inch wet. For the Oregon pine specimens tested, it was about 500 lb. per square inch dry and 350 lb. per square inch wet, the specimens being cut from the one piece of timber. These figures are considered slightly below the average value for wet hoop pine and above for wet Oregon pine. The stress condition required to modify the yield point characteristic was not established.

(c) Stacks of blocks of height and width as used at Cairncross will fail by direct crushing, or splitting associated with crushing, and not by elastic instability (column action).

The ultimate strength of any stack subject to load concentrated over part of its length, such as might occur under the after cut up of a heavy ship, should be not less than 300 tons, and, if the load is uniformly applied, it should exceed 600 tons, although the ultimate strength of a stack of members of the highest quality throughout might be up to 50 per cent. higher than these figures if the timbers were properly seasoned and dry. However, since in some cases loads much below these values might cause permanent distortion, the maximum safe load on a stack should be assumed 300 tons in order to limit distortions and a maximum average working load of 150 tons is recommended, which load can be taken on pine caps without excessive yield. Moreover, blocks become saturated in the dock and consequently are then weaker than they would be if dry and seasoned.

For practical purposes with medium loading, the load-yield relationship for a stack as tested may be taken as 0.004 inch yield per ton loading with 4-in. thick capping blocks of old well used pine and 0.003 inch with hardwood only, although the relationship is not actually linear.

(d) A cribbed stack or "pigsty" arrangement, besides being more stable, will probably be stronger than a stack of parallel members of the same projected area, particularly for long sustained loading. The test indicated an increase in strength of 10 to 15 per cent. when the grains in adjacent blocks were perpendicular as compared with parallel grains.

(e) The ultimate strength of a stack built up from reasonably sound heavy blocks of any of the hardwoods included in Strength Group "A" of the C.S.I.R. classification, care-

Compression Tests on Docking Blocks—continued

fully fitted together and loaded perpendicular to the grain, may be assumed as approximately ½ ton per square inch, if no column action can take place, provided the timbers of each layer have similar elastic properties and there are no heavy concentrations of load. Stress greater than this can be expected to produce some plastic yield continuing for a considerable time (i.e., creep), which may eventually lead to a dangerous condition. A certain amount of creep may sometimes occur even with a stress of ½ ton per square inch in the case of the weaker grades of timber, but should not lead to failure unless the blocks were of very poor quality. In the case of specially selected sound blocks of the strongest timbers in the Series (a) tests, such as iron-bark and spotted gum, the ultimate strength will average well above ½ ton per square inch. The above remarks, too, apply to wet timbers. Dry, well seasoned blocks would be appreciably stronger. Probably Series (a) timbers can be allowed to be compressed about 1½ to 2 per cent. of thickness without serious internal rupture.

(f) With single large specimens of hardwood, loaded perpendicular to the grain, the commonest form of failure was shear along growth rings starting from an area in which these were inclined at about 45° to the load. Ring checks, when they were present, seemed to provide a starting point. The consequence was that failure frequently occurred with a roughly triangular section of a block shearing off.

In the case of a stack of blocks all with parallel grain, failure commonly occurred by nearly vertical shear through the timbers, with the plane of failure often extending into adjacent blocks. This probably originated from uneven thickness or shrinkage or from non-uniform elastic properties; the arranging of adjacent blocks to have their grain perpendicular greatly reduces this tendency.

(g) Tests carried out to examine the effect of certain defects in timber, such as checks, gum veins, borer holes, etc., showed surprisingly small reductions in strength under direct compression perpendicular to the grain, although the yield under load was frequently much greater in the defective pieces, and this would affect the strength of a stack in greater proportion than the ratio of strengths of defective and sound individual blocks. Ring checks or shakes probably weaken a block more than radial ones. The scope of these tests was too limited to enable general conclusions to be drawn.

(h) Anti-splitting bolts seem to serve a useful purpose, but the washers and rivetted ends as fitted are not very efficient, and ungalvanized washers had been appreciably weakened by rusting.

7.—Some Results Already Published.

Before the completion of the test programme, a preliminary draft of part of this report, covering the first section of the work only, was made available to the Department of Harbours & Marine to enable information therein to be recorded in the annual report of this Department for the year ending 30th June, 1945.

8.—Photographs.

The accompanying photographs show the way blocks were set up for tests, and illustrate the nature of some of the blocks before and after the test.

Photograph "A" was taken during Test No. 1 and shows the 4-ft. high type of stack, with a pine cap, when carrying a load of about 450,000 pounds applied over a central length of 15-in. The fittings for measuring the strain are hidden behind the screwed column of the testing machine. In photograph "B" the load has been removed and the capping block has partly recovered its shape. The load was removed immediately after photograph "A" was taken.

9.—Acknowledgments.

The investigation was carried out in the University of Queensland, Engineering Department Laboratory, made available by Professor R. W. H. Hawken for this purpose. The programme of tests was under the general direction of Mr. W. H. R. Nimmo, Chief Engineer, Stanley River Works Board, and Chairman of the Board of Engineers for Cairncross Dock, in consultation with Mr. C. M. Calder, then Principal Assistant Engineer, Department of Harbours & Marine, and the work was generally planned and supervised by the writer. Mr. W. Mapp, assisted by Messrs. C. and R. Mapp, of the University of Queensland Laboratory staff, whose assistance is gratefully acknowledged, carried out the actual testing. The photographs were taken by Mr. C. Lewis, of the Main Roads Commission.

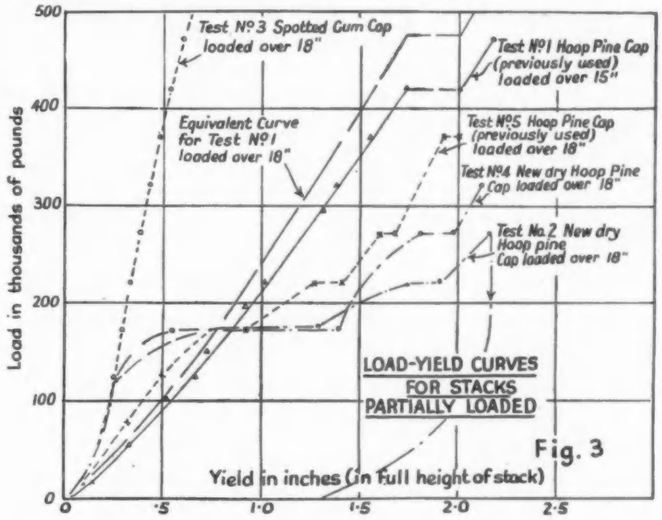


Fig. 3

ADVANTAGES AND DISADVANTAGES OF PINE CAPS FOR DOCKING BLOCKS

In the tests carried out, there was found to be a fundamental difference in the behaviour of pine and hardwood when loaded perpendicular to its grain. Within certain limits, both materials act elastically, and, when overloaded, a non-elastic yield with prolonged creep occurs, but from then on the behaviour differs. The pine will compress into less than 50% of the original volume without complete disintegration and still continue to carry load, but sound hardwood, after a distortion of some 5%, generally disintegrates with loss of ability to carry any further loading.

The pine exhibits a yield point above which there is a great shrinkage with little increase in stress, after which the rate of change of the ratio of stress to strain once more increases, as may be seen from any of the typical load-strain curves (Figs. 1 and 4).

This property is a valuable one in docking practice, since, if a ship has a low spot, or one block higher than the rest, the irregularity will be taken up by the yield of the pine cap without a very pronounced increase in the load on the block and the corresponding load on the ship's bottom.

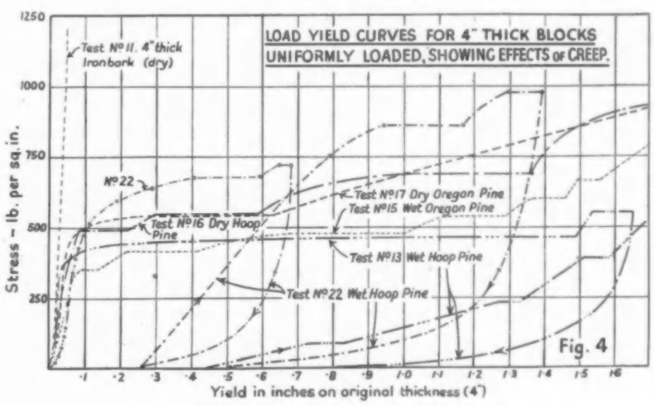
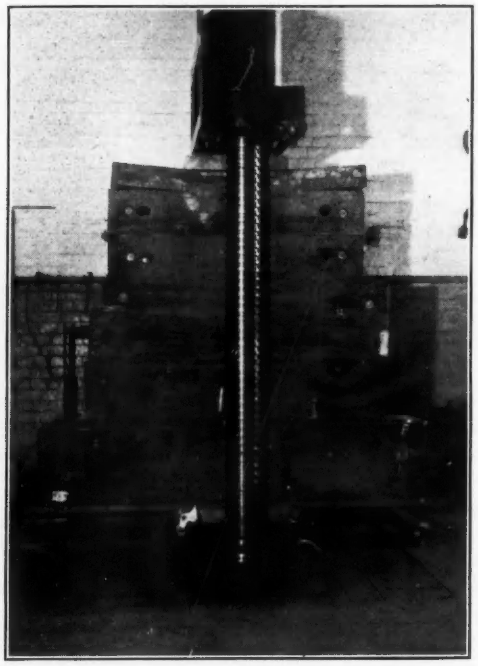


Fig. 4

Compression Tests on Docking Blocks—continued

With a cap of Australian hardwood, however, the condition is very different, since the whole of the stack is much more resistant. For example, if one block in a group carrying an average load of 100 tons each were to be too high by ½-in. and if the ship's bottom were unyielding, a block with a pine cap of average resistance could have its share of the load increased to about



Photograph A. 4-ft. Stack of Blocks with hoop pine cap set up in testing machine for Test No. 1. Load approximately 450,000 lb. applied over central 15-ins.

190 tons, an increase of 90%, but with a hardwood cap (or all hardwood blocks) the load might be 330 tons, an increase of 230%.

With an average load of 150 tons on each block, equivalent to 50 tons per foot run of keel without help from outer line blocks, the figures for the increased loadings would be about 200 and 365 tons respectively, but, if all pine caps were very soft, with identical properties, and they had not previously been loaded beyond their elastic limit in compression, all stacks might be loaded to beyond the yield point of the capping material, and the increase in load on the high stack might not be very great unless the stacks all settled down considerably. If the capping material in the high stack were appreciably less dense than the average, it might even have to carry no greater than average loading. This is due to the fact that wet new hoop pine of comparatively low density has a yield point not greater than 400 lb. per sq. inch, which corresponds to a load of about 300 kips or 140 tons on a stack of blocks, and a yield of over 1-in. might occur in a 4-in. thick cap with very little increase in load. These assumptions may be extreme ones, but as it seems a little hazardous for the ship to tolerate an uncontrollable and uncertain yield of about 1-in. in addition to the general elastic yield of the stack, it is suggested that the average design load on blocks should, when possible, be restricted to some 20 tons per sq. foot of blocking area, which is equivalent to a load of 310 lb. per sq. inch and about 110 tons for each block stack. Such a restriction should ensure that the capping blocks would not be loaded beyond their yield point, and still provide a small margin for error. A 25% increase on these figures should still be safe, i.e., 25 tons per sq. foot and 130 tons per stack, but the lower figure should be aimed at.

Loadings far above 110 tons per stack can be safely carried, but the approximate straight line relationship of load to yield cannot be assumed to hold with pine caps when it exceeds about 130 tons.

Even within this range, the relationship between load and yield will not be the same for all pine caps of similar material, as it will be influenced to some extent by the density of the wood, its moisture content, amount of service and previous loadings, and this will affect the distribution of load between ship and blocks. Since this variation, however, appears likely to be of less magnitude than variations due to uneven heights and bedding of blocks, it does not seem a very important point.

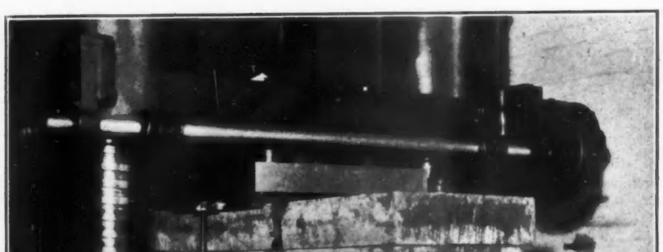
The case in which the distribution of load under a ship were such that only certain groups of blocks would be loaded beyond the yield point is of some importance. In this case, for a condition of no bending in the ship's structure as a whole, the resistance of the blocks and load per block would be fairly uniform, or follow a uniform graduation. Hence the heavy portions of the ship would not be completely supported by the blocks under them, but only partly by these blocks and partly by beam action in the ship's structure.

This would involve uneven yield in blocks and deflections in the ship's structure and perhaps heavy bending stresses, which might or might not be dangerous but are objectionable.

The case of heavy aircraft carriers is one in point, in which the weight might average 50 tons per foot run of blocked length, but in which the maximum weight per foot run might be 70 or even 80 tons, quite apart from the condition at the after cut up. At 110 tons per block, the maximum designed load per foot run should not exceed 37 tons for a line of docking blocks spaced at 3-ft. centres. Consequently, it seems essential (apart from other requirements not here discussed) to supplement the normal centre line blocks for such heavy ships, but, as this would be usual procedure even with all-hardwood blocks, and is frequently facilitated by the provision of docking keels, it does not limit the applicability of pine capped blocks. Sufficient blocks for the purpose are available at Cairncross. Where necessary, supplementary centre line levels can be added between the usual ones, in addition to side line or bilge blocks.

To Sum Up.

In docks overseas, elm cap blocks seem to be commonly used, but no comparative figures of elm, when loaded perpendicular to its grain, have been obtained to date. It is, however, definitely much below ordinary Australian hardwood in strength and hardness.



Photograph B. Test No. 1. Load released. Note partial recovery of shape.

Available data indicates that English elm (ulmus procera) is generally weaker than hoop pine in all properties. Wych elm (ulmus glabra) is a little stronger. For example, the density in

Compression Tests on Docking Blocks—continued

lb. per cubic foot at 12% moisture is given as 32 lb. for elm (ulmus procera) and as 33 lb. for hoop pine by the D.S.I.R. (England) and C.S.I.R. (Australia) respectively, and Markwardt (in "Wood as an Engineering Material," Proc. Am. Soc. for Testing Material, Vol. 43, 1943) claimed that the compression strength perpendicular to grain at the proportional limit of a timber in general varied with about the 2.25th power of its density, suggesting that hoop pine should not be inferior as capping material to English elm.

Use of pine caps will not reduce the ultimate strength of a stack of docking blocks, but will greatly increase the deflection under heavy loading as compared with all-hardwood ones. With haphazard load distribution over blocks, this might be dangerous in the case of very heavy ships, but with planned blocking the yield of the pine becomes a desirable asset to minimise "hard spots". In the case of Cairncross Dock, there seems no apparent reason why pine caps cannot be satisfactory for docking the heaviest ship that can enter.

ANTI-SPLITTING BOLTS IN BLOCKS

Anti-splitting bolts are fitted near the ends of blocks in order to resist the tendency for checks and shakes to open, and in addition they probably add some support against failure under compression. The tests gave some interesting sidelights on their behaviour, although the evidence obtained was necessarily very meagre and no quantitative comparisons could be made from the limited evidence.

It was noticed that the blocks, when unrestrained, expanded laterally some ½-in. in the 15-in. width before complete failure, and in the case of tests Nos. 6, 7 and 8, the higher values obtained in tests 7 and 8 for end sections over that in test 6 for the centre section of a block may have been due in part to the restraint from the anti-splitting bolt. When the washer on the bolt through block No. 8 finally came off, the block collapsed at once.

The newer 6¾-in. blocks used had bolts and nuts instead of rivetted ends, and during test No. 3 the bolt head, in one case, was pulled completely into the wood a distance of about 1½-in. There was no washer on this head, but there was one behind the nut, and this end held. It seems advisable to use washers under the bolt head in such circumstances.

It was noticeable that in the case of rivetted ends, failure always occurred by the washer pulling over the field rivetted end of the bolt coincident with failure of the rivet head, but in all cases the washers dished and even folded over badly. Due to war emergency conditions, washers much thinner than shown on plans were used—measuring about 3/32-in. in thickness—and the ungalvanised ones had lost a fair proportion of their thickness due to rust. For example, one measured under 1/16-in. thick after the rust had flaked off. The anti-splitting bolt holes did not seem in any way a source of weakness.

It seems evident that the washers used on the bolts were too light. No evidence could, of course, be gained from isolated tests as to the most desirable diameter and whether a diameter other than ⅝-in. as adopted would be better in any way, but this size appears satisfactory, provided the end fittings are adequate.

Theoretical considerations suggest that, for a yield strength in the bolt = 30,000 p.s.i. to be reached simultaneously with a bearing strength in the timber under the washer = 2,000 p.s.i., washers would require to be 2½-in. diameter by at least ½-in. thick.

This is much greater than used in practice and greater than would in general be necessary, but it is recommended that washers under the heads of anti-splitting bolts be not less than 2-in. diameter by ¼-in. thick and galvanised, and, if not galvanised, that the thickness be at least 5/16-in. or 3/8-in.

The rivetted bolts, however, were found to be often not tight, and the block could spread noticeably before the washers and rivet heads became loaded.

Perhaps these blocks had dried out and shrunk sufficiently to loosen the bolts, but it seems advisable to fit bolts so that the heads or washers bear as firmly as possible on the timber.

Liverpool Observatory and Tidal Institute

Excerpts from Annual Report for 1948

The Institute was requested by the Hydrographic Department of the Admiralty, and the Hydraulics Research Organisation of the Department of Scientific and Industrial Research to prepare comprehensive reports on the estuary of the Severn and the Forth. All available data have been collated, and much analytical work has been carried out. Some of the observations were taken scores of years ago, for short periods, or during daylight only, so that special methods have had to be designed to cope with the problems set. The reports include all the results of the analyses, and for a large number of places they give mean tide curves for various ranges of tides, and they also include curves showing the elevations of surface along the estuary at intervals in the tidal period. These reports will be of very great service in connection with investigations into the two estuaries. So far as is known these reports are not being published, though they are of permanent interest and value.

In tracing the changes of the tide-curves as the tide moved into shallow water, Mr. Corkan, in the Severn Estuary, observed that the quarter-diurnal and sixth-diurnal tides did not change according to the laws usually assumed. A quarter-diurnal tide, for instance, may normally be expected to change in range according to the square of the range of semi-diurnal tide. This law rather assumes that the eighth and twelfth diurnal tides are negligible, which is not true in the Bristol Channel, and it was known theoretically that when these tides are generated there are accompanying quarter-diurnal tides which will separately vary in range according to the fourth and sixth powers of the semi-diurnal tide. The investigations referred to showed up these effects in a remarkable way, for the range of the quarter-diurnal tide increased much more rapidly than the "square law" would indicate, and the contributions under the higher laws were isolated. When our copious researches on shallow-water tides are written up, this particular research will be described.

The commercial work referred to above has hindered other research work such as that which Mr. Corkan had under consideration in relation to numerical methods of determining the tides in seas and oceans.

The large-scale work at sea which was projected could not be carried on to the extent that had been expected, owing to delays in the work of preparing the ship for sea, and the lack of time available before the conference at Oslo, but experiments were conducted in the Mersey for several weeks, using the current meter and the special Favé meter which had been adapted for quick records of varying pressure due to waves. The meter was suspended from a framework placed on the bottom of the sea. This framework has been constructed at the Observatory, and it enabled the current meter to record fluctuations of current quite near the bottom of the sea, without being affected by the movement of the ship. This work is being done in association with the University Department of Oceanography, and the results will be investigated by Professor Proudman and Mr. Bowden.

Machines

The design and construction of tide-predicting machines continues to be of dominant interest. A 16-component machine for Spain by Kelvin & Hughes, Ltd., was completed in Glasgow and tests were made on two occasions by the Institute. This machine was generally on the lines of the older design but with many improvements in detail.

For some time the work of the Institute has shown the need for replacing its Kelvin machine of 30 components by one of 42 components, and when an offer was made by a foreign government to purchase the 30-component machine, it was decided to design and construct a new machine in its place. A completely new design of component gearing has been elaborated by Dr. Doodson as a

Liverpool Observatory and Tidal Institute—continued

development of the general Doodson-Légé design, and the order has been given to Légé & Co. to construct the machine in a modern style of case designed by that firm. The new gearings will be much more efficient than the old ones, and the maximum error of angle for any component will be less than 0.05° per year, which is very much less than was found possible under previous designs. Several hundred gear ratios for each component were computed by the Institute's original methods, and a choice was made to suit practical limitations of design. All adjustments of amplitude and angle will now be made on the front plate of the machine, whereas previously the angle plates were on the rear face of the machine and the clutches were between the plates. The drawings for the design have all been prepared at the Institute.

Advice has been tendered to two foreign governments regarding the design of machines. Difficulties of currency cause many delays in these matters, but the Coast and Geodetic Survey of the Republic of the Philippines, Department of National Defense, have decided to have a 30-component machine made under the supervision of the Institute.

No further progress has been made in connection with the 10-component machines of the German type.

The Institute completed the construction of the two current meters and two Favé meters during the year, and added to its engineering equipment a milling machine and an engraving machine.

Analyses

Tidal analyses of various types and for widely-spread areas have again absorbed much of the Institute's resources. The preliminary analyses of the European ports have been completed, as also has the reading off and computing of mean sea levels for 31 years of Australian records. Canada has again supplied a quota of work, and there have been requests from the Admiralty and other authorities for analysis and prediction of new places.

A large part of the year's work has been devoted to detailed investigations into the tides of the Severn Estuary and the River Forth, but a number of additional analyses of tides and tidal streams for periods of one or two days have also been made. Usually these analyses have been used to obtain a comparison with the tides at a standard port, and hence to determine average curves. Average spring, mean, and neap curves were deduced for seven tidal stations and seven stream stations in the Bristol Channel, and for ten tidal stations in the Forth.

Predictions for Almanacs

The supply of predictions to almanacs, and to private publishers, continues at a high level. The removal of all restrictions at the close of the war has resulted in a large number of publishers requiring information. In many cases the required predictions are for the more important ports, especially Liverpool and London. The Institute is highly privileged to be able to supply publishers with copies of predictions which have been prepared for the Hydrographic Department and for tidal authorities in the Dominions and Colonies. The friendly relations which exist with many foreign hydrographic authorities also permit of an exchange of publications and the Institute is thus allowed to supply publishers with copies of the officially accepted tables. Except in a few cases where this arrangement does not hold, the Institute does not prepare a special prediction if an official one exists. It is the policy of the Institute to supply only predictions of the highest possible merit even though such predictions are more costly than many publishers like, but a large number of publishers have come to realise the benefits received through this policy.

The number of places for which predictions for 1950 have been prepared has decreased owing to the cessation of a large almanac.

	H.W. Times and Heights	H.W. Times only	Total
1949	32	56	88
1950	32	45	77

In most of the cases many copies have been prepared and so all the tables are reproduced by photographic processes.

Though many publishers prefer to give times in the a.m. and p.m. system, with heights in feet and inches, and to use special datums for certain docks, it is the policy of the Institute to supply only predictions in the 24-hour system, with heights measured in feet and decimals from Chart Datum, as otherwise there would be endless confusion. Strict supervision is maintained to ensure that all predictions are published with proper acknowledgment of the source of supply and the copyright.

Tidal Predictions

The number of full tidal predictions prepared for 1950 shows little change from the previous year.

Prediction for	British Isles	Europe	Canada	Africa and Atlantic	Asia	New Zealand and Australia	TOTAL
1949	20	8	24	16	56	23	147
1950	20	6	26	16	54	24	146

All these refer to full predictions for which high and low water heights and times are given.

The predictions for 1939, computed before the war, totalled 81.

Review

Annales des Travaux Publics de Belgique, 1948. Six parts. G.I.G., Brussels. 260 Belgian francs. (822 pp.)

This interesting review contains two articles of navigation interest. One is a very complete study of Belgian ports by means of models, by Messrs. Bonnet and Lamoen, written in French, with a summary in Flemish. The other is on "The Transport of Bed Material by Running Water," by M. Heyndrickx, written in Flemish, with a summary in French.

The first deals with models of Zeebrugge and Ostend, two ports very differently arranged. At Zeebrugge the problem is to maintain the depths in the sheltered area behind the famous mole and, in particular, to ascertain whether the open water passages at the root of the mole should be closed or altered to reduce silting. The scale of the model was 1 in 650 horizontally and 1 in 64 vertically, the "distortion" thus being 10.16. [A model made at Delft for Zeebrugge was provided with a horizontal scale of 1 in 400, giving a distortion of 6.67.] The British precedent of much greater distortions is quoted, and it is stated that "it results from these data that the distortion of 10.16 for the model of Zeebrugge is perfectly admissible." The logic of this statement is not very clear, and the matter is further complicated by an arbitrary scale of velocities of 1 in 4.4, "in order to realise in the model currents sufficient for the transport of solids by bed drag and in suspension." The paper is well illustrated with plans and photographs. The conclusion drawn from the experiments is that the openings should be deepened and that training walls should be constructed in the sheltered area to guide the currents. It is anticipated that in this event no accretion should occur, except in extraordinary conditions. The wave motion was also studied.

In the case of Ostend, the approach is through a canal which is silted by the tide and has to be dredged to an extent of about a million cubic metres per annum. The mud is very light, only containing 0.288 kilogrammes of dry solids per litre (density about 1.2). The object sought is to reduce the formation of eddies at the entrance so that the deposit of silt shall be a minimum. The scale of the model was 1 in 400 horizontal and 1 in 60 vertical. The conclusion drawn here was that the western mole should be prolonged 80 metres. It is also indicated that deepening of the port does not increase the siltation.

Both these model studies are well worth study.

M. Heyndrickx' article on sand movement is very comprehensive and well worthy of attention. It is an excellent summary of the studies made in field and laboratory, but as is so often the case, overlooks the vast amount of work done in India, and the conclusions of Kennedy, Gerald Lacey, Inglis and others. It is rather remarkable that the countries in which the transport of silt and sand by rivers is almost unparalleled are rarely referred to by European writers on this subject. The Yellow River provides the example par excellence, but there is some excuse

Review—continued

for its neglect as, apart from studies by Freeman, Van der Veen, Van Salverda, Engels, Todd, Eliassen and others, there are not many data, but in India the reports of the Central Irrigation Board provide a tremendous amount of information, and the extent of river and canal works exceeds in magnitude even that of the United States.

M. Heyndrickx uses to a great extent the Du Boys formula for bottom drag and gives in considerable detail the results of studies made to determine the mechanical conditions which determine when that drag causes movement. He does not seem to have considered the conclusions of "soil mechanics" in this connection. This is a matter which is well worth further investigation.

Bottom drag in tidal streams is more difficult to analyse than the uni-directional effect in rivers, but the two are certainly related and it would be of much interest to have a comparable study of the movement in tidal channels.

H. C.

Highways for Seaways

By THE RT. HON. LORD SANDHURST, O.B.E.
(Chairman of the British Road Federation, Ltd.).

The romance of the road has been sung by writers and poets down the ages, but a special romance clings to the dock road, for here is a highway which truly leads to the ends of the earth. Down it pass pioneers, adventurers and seafarers, and that wealth of goods which go to make the international trade without which a nation living by ships would die.

The function of a port is to provide a link between sea and land transport. When examining this function, it must be remembered that a ship, with its enormous burden of overheads—high construction cost, insurance, fuel consumption, maintenance, rapid depreciation and big wage bill—is an economic machine only while it is on the high seas; every moment that it is immobilised in harbour is a loss to the shipowner and the country. Recognising this fact, all port authorities strive continuously for quicker turnround of the vessels temporarily in their charge. All forms of mechanical cargo-handling plant are installed, spacious sheds and warehouses are provided, with modern dock sheds and warehouses having specially designed bays for loading and unloading road transport, so that nothing may delay the unloading of the ship. In fact, all that modern planning can do is done to reduce the time factor and return the ship to her lawful occasions. But without distributive transport, and particularly road transport, all these efforts would be neutralised and the ports would speedily suffocate with the glut of cargo.

A glance at the map of Great Britain shows that all major roads, railways and inland waterways converge upon our ports. Up to comparatively recent times each port served a fairly well-defined hinterland. But, although the cost of a long haul still influences, to some extent, the port of loading, the post-war shortage of tonnage and the vital need to sustain the outward flow of manufactured goods tend to make "When is the ship sailing?" more important than "Where is she loading?" Land and inland-water transport alone make possible this swift transfer of cargo from the manufacturer to the ship. In this distributive web, road transport is rapidly increasing in importance. Our overburdened railways could handle nothing like the enormous volume of cargo being sent overseas. Our canals have, in the main, been sadly neglected. It is the roads to the docks which bear an increasing burden in feeding the ships loading for overseas.

Certain ports, such as London, are predominantly "barge" ports, and statistics of road traffic to and from British ports show considerable variation. About 70% of the import and export cargo handled over the dock quays of the Port of London, more than 75% of the total inward and outward traffic of the Port of Glasgow, and about $33\frac{1}{3}$% of Bristol's overseas trade are handled by road transport. Profiting from the lessons of the 18th century, when the lack of road access caused such a glut of cargo at the London wharves that the attendant wholesale pilfering inspired the design of the enclosed docks, most ports have long since recognised the need for facilities for road transport. Some of the roads parallelling dock quays are among the best in the country. In 1934 a new approach road was driven through a large area of dockside slums, sacrificing a not-unimportant ship lock to permit the road to sweep over a magnificent viaduct direct into the Royal Docks of the Port of London. But isolated instances like this are not enough. The British Road Federation, representing over a quarter of a million users of road transport, has, since its formation in 1932, consistently advocated that roads should fit the traffic rather than the traffic having to fit the roads. It actively supported the introduction of the Special Roads Bill now before Parliament and is fully alive to the problems connected with road transport to and from the docks. It emphasises that to harvest the full benefit of the facilities provided for road transport by dockland, road access from much farther afield must be improved. At present long-distance road traffic is forced to follow highways choked with motor and trolley 'buses, delivery vans, horse-drawn vehicles, and all the heterogeneous mass of slow-moving traffic which make up the daily life stream of our great cities before it reaches, on the last lap of the journey, the actual approach roads to the docks.

It must be admitted that dock companies generally prefer cargo to arrive at their premises by rail or barge because of the unpredictability of the volume of road transport. Labour in our ports is now allocated according to the needs of each berth and shed; no longer is there a large army of surplus "casuals" waiting to be taken on as required. Cargo waiting in trucks on the dock sidings or alongside the ship in barges gives the docks operating staffs an opportunity to forecast their labour requirements. But the difficulties of organising labour to deal with an unknown volume of road transport may be ascribed to an embarrassment of riches, and port authorities do not lose sight of the advantages of a means of transport that requires neither towage nor shunting to the quayside railway spurs.

The manufacturer, of course, unless his premises are equipped with a railway siding or a canal frontage, appreciates that road transport can be loaded at the door of his factory and unloaded alongside the ship, thus saving the cost of extra handling.

Post-war developments may soon invest road transport with even greater importance in the export drive. At least one shipping company is now running an overseas commercial service of converted L.S.T.'s, which, after entering the dock, open their bow doors to permit wheeled transport to drive straight into the ship from a wartime "hard". It seems logical to assume that a two-way service of express lorries loaded with perishables will eventually develop between this country and the Continent.

If visual proof of the part played by road transport in the export drive is needed, be early astir and visit the docks. A seemingly never ending stream of wheeled traffic of all types pours into and out of the dock gates. Government posters aim to infuse something of a crusading spirit into the country's efforts at national recovery. If industry is indeed an army with banners, then the great lorries on the dock roads are its mechanised battalions—battalions without which the export drive would have long since degenerated into a feeble push.

Traffic Through South African Ports.

In 1948 the harbours of South Africa handled 12,282,956 tons of cargo, 2,399,396 tons more than in 1938, the last normal pre-war year. Of the 1948 total, 7,458,558 tons were landed, 4,662,948 tons were shipped, and 151,450 tons transhipped. These figures do not include the heavy tonnages entering and leaving the country through the Portuguese East African port of Lourenco Marques, a total which approaches 4,000,000 tons a year. Durban was again the busiest port, with 2,787,804 tons landed and 3,099,880 tons shipped, followed by Cape Town with 2,269,169 and 956,056 tons respectively. Port Elizabeth came next with 1,430,908 tons landed and 349,201 tons shipped, and East London handled 835,085 tons landed and 124,457 tons shipped.

Coastal Surveys

By R. R. MINIKIN.

The problems arising from all schemes dealing with coast protection, channel maintenance to harbours, or, indeed, all deep hydraulic work, cannot be adequately solved unless a fair contour plan of the submerged land is available. In narrow channels of quiet water there is not much difficulty to obtain this, nor yet is there any between the high and low water mark of tidal shores. It is when the area to be surveyed is extensive and is permanently submerged that difficulties crop up. The survey results from the soundings in relatively shallow water by lead and line, or rod, of submerged bars, or banks, lying some distance from the coast can only be rough approximations, for it is not easy to orient the run or "fix" the soundings. It will also be appreciated that soundings by lead or rod only give the spot level. The procedure is slow—in fact, in some estuaries, before the complete survey is finished, it is probable that the contours of the part first surveyed have radically changed from those already plotted. Thus to get a true picture or contour representation of a sea bed where there are mobile banks is almost impossible, unless an army of men and a fleet of craft are commissioned for the job. It therefore follows that the more quickly the survey is carried out, the closer will be the approximation to the real condition of the sea bed at any one moment.

A comparatively new piece of equipment for the hydrographic surveyor is the echo sounder, which actually measures the travel of a sound pulse from the time of its origin to the moment of its reception as an echo after reflection from the sea bed. Briefly the principle is that the transmission of pulses of supersonic sound through water, fresh or salt, down to the sea bed, river bed, or any solid obstruction, over which they are directed are immediately on contact reflected back to the origin, where they are graphically recorded. The principle is not now new, having for some time been used extensively for navigational purposes; but the adaptation in the instrument used for sounding survey is one of the more recent applications. A typical survey echo sounder is one that can measure depths from a few feet to a hundred feet with consistent accuracy, sensitivity and reliability—in fact, an instrument of precision comparable to any other used for survey work under less arduous conditions.

For our purpose it will be profitable to recapitulate briefly the usual methods of conducting a sounding survey. First, a boat is required, a motor boat, or more usually one propelled by two oarsmen, a man to pay out a distance wire from a winch in the stern of the boat, a soundsman to heave and read the lead, and an engineer or surveyor to record the readings and control the operations. Sometimes in place of a man paying out a wire, two surveyors or technical assistants are located on shore, and, when signalled at the moment of sounding with the lead, they take readings from their instruments, locating the position of the boat. Whatever the method, the spot soundings must be related to the shore. The procedure is a follows:—

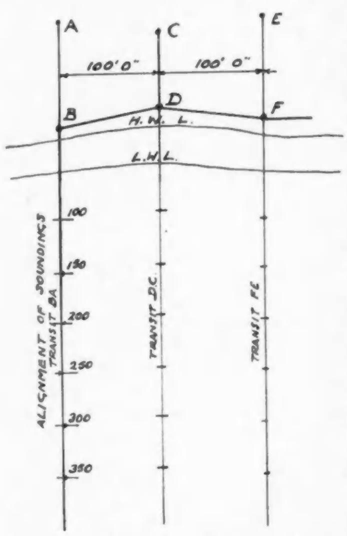


Fig. 1. Plan of soundings transits

First Method:—A base line B.D.F. etc. (Fig. 1), is laid out as close to the high water mark as possible: this need not be straight. The distance apart of the flagged points depends upon the purpose for which the survey is required; if for a jetty, the interval may be 20 feet; if for coast work 100 to 200 feet. Inland from these points, flagged or painted poles, A.C.E., etc., are planted at any convenient distance, but located so that the lines joining AB, CD, EF, etc., are parallel. This is not imperative, but convenient. All these several points are then related to the topography of the area, so that they can be accurately plotted. The boat is then placed in position in the line AB of the first flag group. The zero end of the measuring wire is secured by a stake at the point B. This wire is of copper, about 3/16-in. diameter, and it is marked with brass bands carrying indented figures giving the distance from zero at every 5 feet; at every 100 feet there is a swivel to avoid twists; the amount of wire on the winch drum is sufficient for measurement up to 1,000 feet. The winch is provided with a brake to regulate the paying out as the boat is pulled seaward, keeping in the line of the flagged poles AB. The surveyor orders the lead to be dropped and the sounding taken at the required intervals, as measured by the distance wire. He then records the distance from the point B, the sounding, the clock time, and any other information, such as deviation to the right or left of the line AB, at the time of sounding. This latter observation is more often than not of a perfunctory nature. When the outward run is completed and all the wire paid out, the boat has to return to the shore, winding in the wire by the winch. Sometimes the winch is placed in the bows of the boat and the operations are commenced when all the wire is paid out, that is at the seaward end, and the run is made towards the shore with the help of an extra man as steersman. If the men are not used to it, however, this variation of method is not satisfactory; the boat either over-runs the wire, or breaks it by too great a strain. The natural difficulties of keeping the boat on the line AB are obvious. The difference of the true distance from the shore and that given by the wire measurement is negligible when the reading is corrected for sag. If the wire is just taut enough to form a catenary, giving a sag at the centre of depth d (Fig. 2), then the difference between the true and the measured distance will be $8d^2/3l$ where l is the true length, but in this case there is little error in using the measured length in the denominator. For example, if the sag is 12 feet and the measured distance is 480 feet, then the measured distance is too long by 0.8 feet.

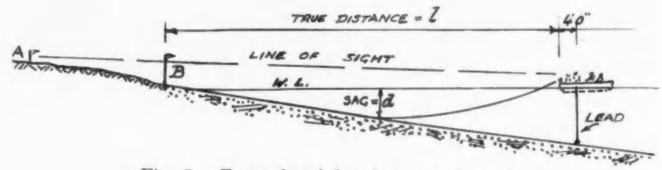


Fig. 2. Example of Sag in measuring wire

In a strong current running along the shore, the author has found it less fatiguing on the oarsmen to incline the transit lines, such as AB and CD, to the shore, in the direction of the current.

It will be appreciated that in the lapse of time to take one run of soundings and another, there will be a difference of tide level, which in places of high tidal range may be considerable. To co-ordinate this variation to a common base, it is usual to reduce the actual depth readings to what they would be at low water level. This is done by the use of the following formula:—

$$h = H/2\ (1 \pm \cos\ (180t/T))$$

Where H = vertical rise of tide between high and low water in feet.

T = period of time between high and low water in hours.

h = height of measured water level above low water at time t in feet.

t = difference in time of sounding to time of low water in hours.

When $180t/T < 90$ degrees, minus Cos is used,

and

When $180t/T > 90$ degrees plus Cos is used.

Coastal Surveys—continued

For example, if high water is at 07.00 hours and low water at 13.25 hours, a sounding taken at 11.00 hours reads 20 feet. What was the depth at the spot at low water, the vertical rise (H) being 36 feet?

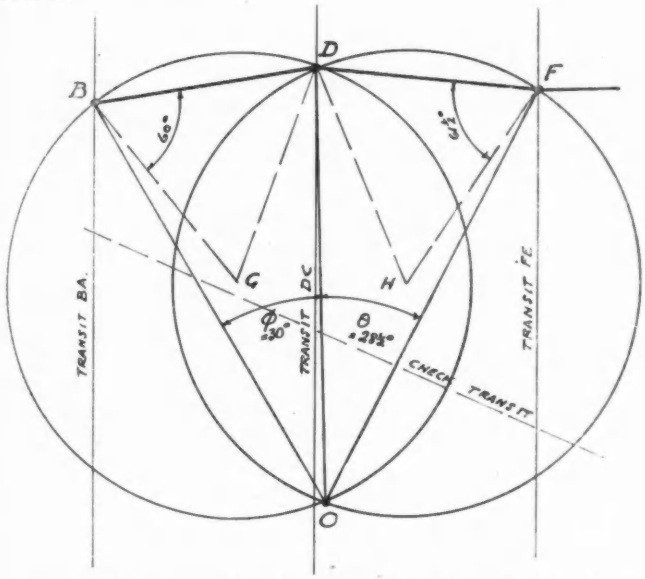


Fig. 3. Plotting position of sounding from observations by two sextants on sounding craft

$$h = 36/2 \quad (1 \pm \text{Cos} \frac{180 \times 2.25}{6.25})$$

$= 18 \ (1—0.4258)$

$= 10.33$ feet.

then sounding = 20.00 feet.
correction h = 10.33 feet.

9.66 feet.

which is the actual depth at the spot, at low water.

Second Method.—This method of survey differs from the one already described, inasmuch that the copper measuring wire and winch man are replaced by two surveyors with sextants. These surveyors, simultaneously with the casting of the lead, take readings of the angles of three selected points of some easily identified prominence. These may be natural features, or painted and flagged stakes on the base line as BDF (Fig. 3). Assume that the surveyors are stationed at O at the moment of observations of the angles ϕ = BOD and Θ = DOF. The distances BD and DF being known and the exact location in the local topography, the point O can be fixed as follows:—Set off from the base BD the lines BG and DG, each making the angle $(\frac{180 - 2\phi}{2})$ with the base BD. Then BG = DG = r = the radius of the circle which, when described from the centre G, will cut through the three points O, B and D. Similarly on the base DF set off the lines DH and FH, making the angle $(180 - 2\Theta)/2$ with the line DF, meeting in H, then the circle described with the radius r = DH = FH with H as centre will pass through the three points O, D and F. Then where the two circles, so described, cut each other in O, is the exact point location of the observers on the boat, at the time of sounding, related to the base line BDF.

Note that in the first method the position of the sounding was only approximately fixed by measurement from the base line, and along a traverse line of doubtful location.

There are other methods, of which one of the more common is to fix the position of the sounding by measurement of the angle made by the lines of sight of two theodolites stationed at two known positions on a shore base line. However, the two methods detailed are least liable to error, as all the observed readings are booked by one person, who, when experienced, can tell at a glance whether they are tolerably correct. The information obtained from the two methods is the data upon which, when reduced and plotted to scale, the spot levels of the sea-bed, in the area traversed, is fixed. The intermediate levels between the spot levels, which have not been sounded, are presumed to lie on a straight line joining the spot levels. Thus if the intervals between the spot levels are very great, some important detail of the unseen sea-bed may be overlooked, such as a ledge of rock, or a sunken craft. In areas close to jetties or for breakwater construction, the intervals may be as close as 10 feet, whereas for channel dredging, and close coast work, they may be 100 feet.

The more modern method for speed and overall accuracy is that of supersonic echo sounding, which gives a continuous reading of the depths of the sea-bed over which the apparatus is traversed, and takes the place of the spot depth plumbing of the sounding lead. A suitable equipment which is compact and can be made either permanent in a craft (Fig. 4) or "portable," comprises a Recorder/Amplifier Unit, Transmitter Power Unit and either an Outboard Oscillator Unit, or two Inboard Tank Units. If Authorities have a boat or launch which would be engaged solely on survey work, the inboard tank arrangement is the more suitable, but the outboard oscillator unit has the advantage that it may be used on any small boat (Fig. 5) by attaching it to a portable frame. Expense and time can be saved by Authorities responsible for carrying out surveys in widely separated areas, as the apparatus can be sent anywhere by the quickest conveyance, and installed on almost any craft obtained locally, in a very short space of time. Full technical details of a survey echo sounder can be had from the manufacturers, but it will give a better understanding of the adaptability and limitations of the apparatus to briefly outline the functioning of the echo sounder chosen as a typical example of this type of equipment (Fig. 6).

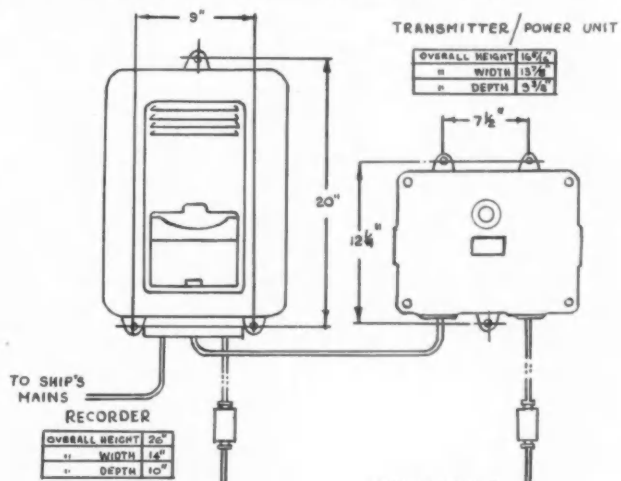


Fig. 4. Echo sounding apparatus fixed in hull of survey craft

To produce the pulse of supersonic sound a high voltage discharge through the magneto striction oscillator is originated by triggering a Strobotron tube in the transmitter power unit from a set of contacts in the recorder. The contacts are closed at every revolution of the stylus as it passes the zero, or left hand edge,

Coastal Surveys—continued

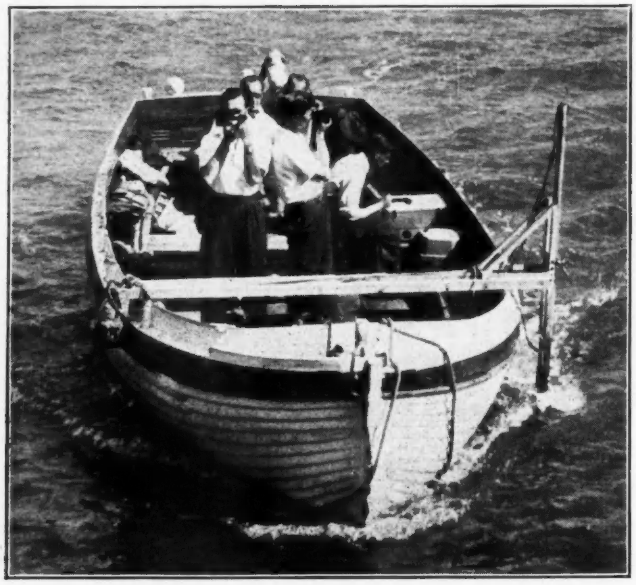


Fig. 5. The two Surveyors stand alongside the oscillator to obtain a true position of the actual sounding

of the recorder paper. Thus the sound pulse leaves, in effect, the surveying craft as the stylus pen passes the left hand edge of the paper. Whilst the sound pulse is travelling down to the reflecting surface (Fig. 7), that is the sea-bed or river bottom, the stylus pen is moving across the paper at a uniform speed, determined by a closely governed electric motor driving the stylus through a gear box. The sound pulse will travel through the water at a velocity which is within very small limits constant for any given values of salinity and temperature. Determination of these values of salinity and temperature in the area under survey need not be made individually so long as their total effect is known, and this can be found by a simple calibration known as " the bar check." After reflection from the sea-bed the sound pulse is received by an oscillator similar to the transmitter, passed to a high gain amplifier and then to the stylus pen. The pen marks the recorder paper as the electric current (being the rectified reflected sound pulse) passes from it through the recorder paper to the metal plate underneath the paper (Fig. 6). It will be appreciated that as the pen has moved some distance across the paper before the received and amplified sound pulse marks the paper, this distance is related by some scale to the distance the sound pulse has travelled.

In the particular equipment with which the writer is familiar, this scale can be 0—45 feet or 0—90 feet, depending on which scale the surveyor decides to select at the commencement of the survey. By what the manufacturers call " phasing," it is possible to extend the basic scale mentioned above so that the paper width to feet scale ratio is maintained, but depths up to more than 500 feet can be sounded. This is an advantage which the hydrographic surveyor working in shallow and deep water will readily appreciate, as there is no cramping of the depth scale in deep water work, thus allowing the same detailed examination of the sea bottom as is available in shallow water. The limitations of an echo sounder must also be appreciated in order that the surveyor does not over-estimate the capabilities of a very useful piece of equipment.

Remembering that it has descended from the navigational instrument where the great importance is knowledge of the shallowest areas in a navigable channel, the same results are obtained on the survey equipment. This is due to the fact that the transmitting oscillator has a certain " beam angle." In other words, the sound pulse spreads out somewhat like a cone, and thus over a steep slope the depth may appear less than is actually the case at the position which will finally be plotted. (See Fig. 8.) The " error " due to this effect will only be serious where steep slopes are being traversed, and in areas where such slopes occur any method of sounding must be regarded with the utmost caution. Provided an area is well covered with transits, including some at right angles to the shore transits, the true contour of the sea bottom will soon be realised.

The plotting of the results of the survey (Fig. 8) do not present any difficulty, the usual tidal corrections are applied and an accurate scale made to measure the recordings as calibrated by the bar check. The manufacturers supply a varying scale to compensate for shrinkage of the record paper in drying. For coastal sea bed surveys, the echo sounder has for all important works ousted the use of the sounding lead or rod. The reason being that the continuous profile, which is picked up on an alignment run, gives much more information than it is possible to obtain from spot levels, and the duration of the survey is considerably lessened. The shape of the banks of mobile material indicates approximately the prevailing current disposition on the sea floor, and when adequate data is collected, the direction in which the banks tend to travel may be deduced; in fact, the use of the " echo " sounder has provided much valuable scientific information not hitherto disclosed by other methods. Nevertheless, the survey of a sea-bed carried out for coastal work would not be complete if only the bottom contours were sought and obtained; other particulars are required of the strength and direction of currents to cover at least a period of 24 hours. Of course, the meteorological conditions over that interval should also be noted, and also the state of any river water discharging into the sea in the vicinity. It is not always possible to charter vessels specially for the job, and nowadays it is not necessary to

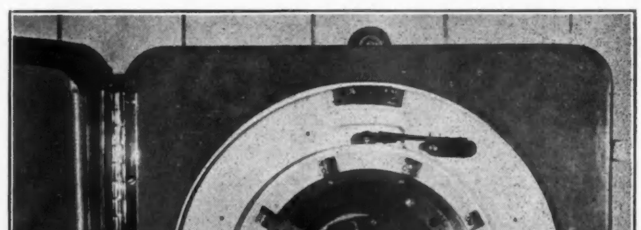


Fig. 6. MS21A Survey model Echo Sounder showing recording paper (cover open)

Coastal Surveys—continued

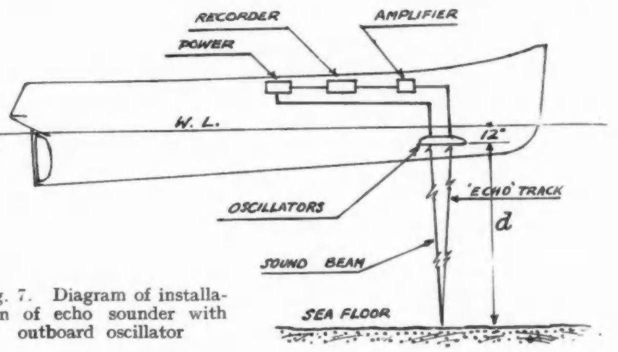


Fig. 7. Diagram of installation of echo sounder with outboard oscillator

do so. The invention of the Roberts Radio Current Meter (named after its inventor, Lieut. Commander Roberts, of the United States Coast and Geodetic Society) solves this problem, which is of great importance in all hydrographic and maritime surveying. This instrument consists of the measuring unit, a radio transmitter housed in a buoy, with its power supply from batteries, a radio receiver, and a pen recorder of an electrical pattern much used industrially.

The measuring unit is streamlined with four aligning vanes and an impeller (Figs. 9 and 10). The rear portion carrying the vanes and internal mechanism is sealed and has no mechanical connection to the impeller. The operation of the mechanism is transmitted from the impeller by a magnetic drive of two magnets, one connected to the impeller and the other to the sealed-up mechanism within the body of the meter. A system of gears gives motion to a revolving contactor. There are two sets of contacts; one is mounted on a compass element and is oriented North magnetic; the other is fixed relative to the meter and is thus oriented in the direction of flow of the current. The revolving contactor translates the directional relationship of these two sets of contacts into a time relationship. The meter is suspended at the required depth from a buoy of special construction anchored in the determined position. Electric cable connects measuring unit to buoy. The meter automatically aligns itself with the direction of the current, and the rotation of the impeller actuates the contact mechanism through the magnetic drive. The set of contacts mounted on the compass and oriented north magnetic are closed when the revolving contactor completes each cycle of operation; this produces signals which, transmitted through the radio antenna to the shore station, are recorded on a slowly moving strip of teledeltos paper by an electrically operated stylus. These signals are constantly emitted; and the spacing on the tape indicates the velocity of the current. The second set of contacts oriented in the flow line of the current, or the axis of the meter, is also closed by the contactor as it completes each second cycle. The resulting signals are passed through the radio transmitter and antenna to the shore station to be recorded. These signals indicate the direction of flow of the current relative to the north magnetic. Therefore on the recorder paper there are two sets of marks; one set, the velocity of the current, being regularly spaced at each

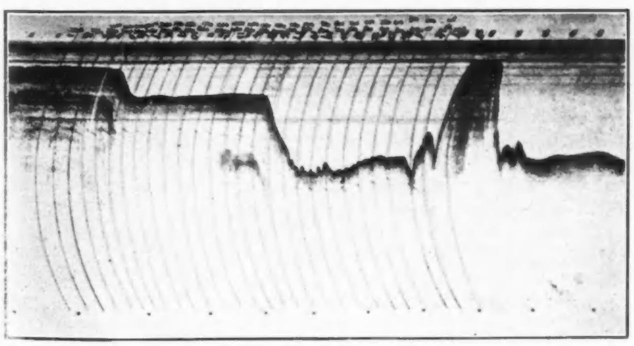


Fig. 8. Part of a typical record marked off for plotting

revolution of the contactor; and the other set, the direction of the current, spaced at every alternate revolution of the contactor.

The time relationship of the signals recorded on the paper are re-translated back to a directional relationship by comparison with a prepared rating table. It is possible to have several of these instruments operating at the same time, which, for sea work, is of tremendous advantage, as thus the variations of currents may be traced through different sections. Another advantage of this type of instrument is that it can be used without danger to personnel during bad weather or near a rocky shore dangerous to craft.

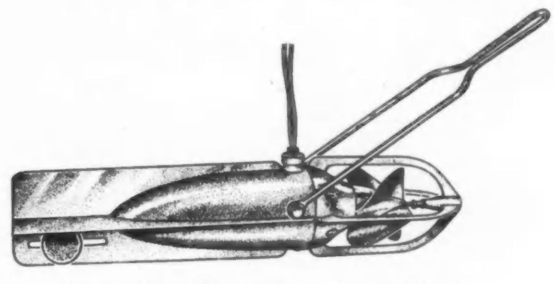


Fig. 9. The Roberts Radio Current Meter

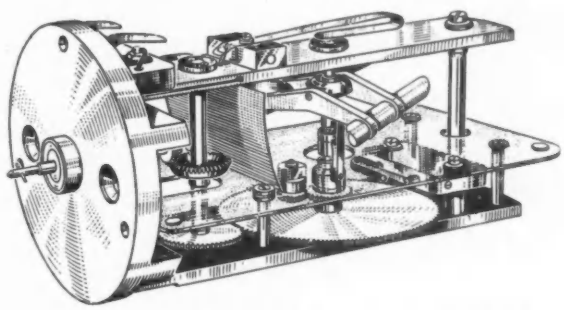


Fig. 10. The inner mechanism of the Current Meter

The author is indebted to the Contract Survey Department of Marine Instruments, Limited (Marine Division of Kelvin and Hughes), who have a world-wide experience of hydrographic surveys, for the use of the photographs and for much valuable technical information of these modern engineering aids.

Industrial Harbour at Maastricht.

It was recently announced that work on the construction of an industrial harbour at Maastricht has been put in hand. The new harbour will be of great importance to the Dutch province of Limburg as well as to Maastricht, especially as many new industrial enterprises have been established there during recent months. Plans for the project were drawn up prior to the war, but were held in abeyance during the German occupation, and after the liberation they were revised to meet the changed conditions. The new harbour which will be able to accommodate ships of up to 2,000 tons, which will be located at the entrance to the Juliana Canal, which is to be broadened. The cost of the new works is estimated to be fl. 1,600,000.

Improvements at the Port of Santander.

Port of Santander, Spain, is being enlarged by the addition of a fishing harbour, a pier, and a wharf for transatlantic steamers. The wharf will be 492-ft. long and consists of 300 blocks of reinforced concrete, each weighing at least 120 tons, and a stone filling. There will be a ballast covering, and an over-bridge will carry cranes and other handling appliances. It is estimated that the placing of the blocks will take about three months, and the wharf will be completed by the end of this year. A loan of £2½ million has been obtained for the development of the port and when the improvements are completed the new wharf will be able to accommodate vessels of 22,000 tons, with a draught of 29½-ft.

Correspondence

To the Editor of *The Dock and Harbour Authority*.

Dear Sir,—

Tidal Models

I am reluctant to enter into further discussion on Tide Models, but Professor Allen's letter in your April issue is gravely misleading. I dealt with a very important term in the tidal equations which he and others have hitherto completely ignored, and I gave *quantitative* reasons for demonstrating its importance. If Prof. Allen wishes to show that my conclusions are erroneous and my analyses invalid, he must likewise produce quantitative arguments. It is self-evident that a model will have different values for the ratio of wetted perimeter to cross-sectional area, and also that the co-efficient of friction may vary because the relative roughness is not the same in the model as in nature, and one could imagine many other factors which affect the model, but in each case quantitative estimates are necessary. For best overall reproduction, all the factors must correct (for the Severn) a very important term from 2% of its value to 100%. Merely qualitative argument is useless. Take the question of the co-efficient k; I can hardly believe that Prof. Allen would say that it would be 40 times greater in the shallow water of the model than in nature! The fact is that Prof. Allen does not *know* the quantitative effect of each of the contributory terms, but hopes for a merely fortuitous combination which will give an overall effect. This is most unscientific, for if an estuary is cut in two by a barrage he does not know whether the overall effects were due to conditions in one half or the other. The only solution is that for each section of the estuary the tidal equations shall be accurately represented.

I could say a great deal about the appeal to the Severn model and its alleged representation of facts, but I shall refrain, except for referring to the appeal to the Bore. A little regard for the theory of formation of bores would show that it is independent of the accuracy of representation of tidal movement in the main part of the estuary. Any wave, large enough in amplitude, and moving "according to depth" at the critical parts of the river, however generated, would produce it, and its appearance in a model gives no valid argument for the accuracy of representation of tides in the estuary itself.

As to whether *normal* tides are of most interest to engineers or not, I can only say that those who write to me are usually more interested in the extreme tides.

I hope that it is clearly understood that my discussion of these problems is confined to tides in estuaries and that my conclusions do not affect the use of models for relatively small areas, as for harbour works. Neither Mr. Wales nor I condemn the use of models, as Prof. Allen seems to imply in his concluding remarks, but there is certainly a need for a more critical attitude to them when they attempt to cope with tides in large estuaries.

Liverpool Observatory and Tidal Institute.
19th April, 1949.

Yours faithfully,
A. T. DOODSON,
D.Sc., F.R.S.

To the Editor of *The Dock and Harbour Authority*.

Dear Sir,—

Tidal Models

The invitation in your Editorial Comment for April last, asking for remarks on Tidal Models, prompts this letter. I appreciate the learned contributions of Professor Allen and Dr. Doodson, and especially value the work of the latter owing to his association in bringing the predictions of the Port of London tides, covering 70 miles of tidal stream, to a fine degree of accuracy when I was in charge of the hydrographical operations there (1922-1943).

If we consider the tank model experiments for ship design, there is encouragement for the estuarial model. In the ship tank model, built to a very small fraction of the real thing, the result emerges, with factors of speed resistance and propulsion clarified, to a remarkable and reliable degree. This is accurate forecasting which we aspire to achieve in tidal models, but the difference in vertical and horizontal scale and the disproportion of silt grains to natural conditions are two serious problems. The oversize of the grains of silt in a model to an actual estuary is very great by comparison; but we may, by higher mathematics, evolve equations for the design of the model which will compensate, to some extent, for this discrepancy.

Models should correspond to the hydrographic conditions as nearly as practicable and where sand or mud content in estuaries call for channel design. I respectfully submit that the explorative data for the model should cover the following points:—

(1) Compare previous estuarial charts for a period of time to ascertain the tendency of the main channel to wander.

(2) According to Geike, long rivers flowing near the meridian line (as in Russia and U.S.A.) erode one bank consistently more than the other due to rotation of the eatrth. While this applies to fluvial, there may be applications for tidal rivers, and a model should be aligned on the same geographical line as the estuary it represents.

(3) Sandbanks in open estuaries tend to elongate seawards due to the upland discharge of river silt over a long period of time. Their heights have a static level due to hydraulic and tidal functions as yet little explored. This elongation, which is a natural phenomenon, should be considered very carefully in laying out estuarial dredged channels.

(4) Ascertain the period of slack water at low tide and high tide at a minimum of 3 points: (1) The seaward end or bar. (2) Middle reaches. (3) Upper basin.

(5) Obtain the direction and velocity of the ground currents over the reaches under special consideration. It is the ground sweeping current which creates the form of bank in erodable material.

(6) A study of the surface current on the discharge period may show divergencies in direction from the lower levels. Likewise the surface currents on the flood tide may show divergencies owing to the shape of the estuarial feeder channels.

(7) If the velocity of the flood stream is found to be greater than the ebb, throughout the tidal period, then the alignment of the proposed dredged channel should be such as to act as a feeder or natural conduit in open water.

(8) Finally, the function of a deep dredged channel flowing between banks which once changed their situation and character, should in effect consolidate these banks by depleting the tributary streams, rendering the subsidiary areas quiescent.

8, Earles Avenue,
Folkestone, Kent.
12th April, 1949.

Yours faithfully,
E. C. SHANKLAND
(Captain R.D., R.N.R.).

Conservancy Officers and Hydraulic Research

With Special Reference to Tidal Models

By Lt.-Cdr. D. H. MACMILLAN, R.N.R. (Rtd.) Assoc. I.M.A.

The Conservancy Officer must, by the very nature of his calling, welcome all hydraulic research, leading to practical conclusions.

Yet as he is charged with the duty of advising his Authority on a wide range of problems, he must be guided by sound and tried general principles, if he is to indicate definite courses of action and practical policy, without involving unnecessary expenditure, false precedents or even unfavourable litigation.

When such an officer, especially if he is a seaman, commences to investigate this subect, he invariably finds that he has been greatly mistaken in imagining that there is an exact and comprehensive branch of science known as hydraulics.

Furthermore, he finds that a certain type of individual who claims to know all, or nearly all, the problems and factors of river and estuarial flow is to say the least a most unhelpful character. If, in desperation, he attempts to search out the secrets of hydraulic flow for himself he find himself wandering in a maze of complicated formulæ, the validity of which is dependent upon the

Conservancy Officers and Hydraulic Research—continued

choice of arbitrary constants which rarely apply to the cases with which he is himself concerned.

As a practical man with confidence in the experience of others, in cases analogous to his own, he may delve into the records of successful practical hydrological experts who have spent long years in the observation of hydraulic phenomena and who have shown how the empirical approach is as yet the only possible one in the formulation of useful data for any given area.

He finds, for example, that the work and conclusions of Thrupp, Beardmore, Reynolds and others of the last century agree with the modern researches of Dr. Gibson in giving reliable figures relating hydraulic radius to the rates of flow governing the bed movements and continued suspension or deposition of various sizes and kinds of detritus. He is also aware of the importance of dominant flow in problems dealing with scour in estuaries.

He is again indebted to Dr. Gibson for the important information that erosive power varies as the square of the velocity of flow and the even more significant generalisation, that the deposition of detritous varies inversely as the sixth power of the velocity.

It is, I think, true to say that had these and similar well-founded generalisations been more widely known and appreciated by Conservancy Officers, many problems concerning the regime of rivers and estuaries would have been greatly simplified.

Furthermore, it is clear to the practical Hydrographic Officer that accurate measurements of static and dynamic features in rivers and estuaries are absolutely necessary and essential for fundamental research, which, in its present state, must aim at providing data which can be relied upon for sound general guidance.

Finally, one is struck with the fact that most hydraulic formulæ are given in the static terms of hydraulic radius, slope and frictional co-efficients, whereas a tidal estuary presents dynamical problems, wherein slope, hydraulic radius, wetted perimeter and discharge are almost constantly varying in relation to natural periods of oscillation, superimposed upon natural river flow, emanating from its head.

It is clear that there is ample room for the work of the tidal scientist, the experienced hydraulic engineer, the physicist and also the practical hydrographic surveyor working as a team, in the correlation of the many complex factors which must contribute to the sum of those features which are observed in nature.

I must confess myself to be incurably inclined towards inductive reasoning and a respect for tried principles which have, in fact, provided accurate and reliable results.

The analytical work of Mr. Gerald Lacey into a mass of data regarding the flow of water in alluvium have led him to the conclusion that when the acrid smoke of academic controversy and the necessary theoretical polemics have blown away, the fundamental unity and grandeur of nature will be seen to be governed by simple underlying principles towards which all research had been moving. Apparently divergent opinions, if soundly based and followed to their logical conclusions cannot but lead to a harmonious reconciliation of all the factors involved.

Personally, I cannot see how one can expect to solve hydraulic problems by the purely deductive method, based upon the assurance of a correct knowledge of all the variables involved in this complex subject, without an assumption of near-omniscience which, on the highest authority, is far from justified by the present state of our knowledge.

I will venture to illustrate my opinion by the facts adduced by Dr. Doodson in his recent paper on tidal models. Dr. Doodson, whose opinion must be heard with great respect, argues that geometrically similar proportions must be aimed at in tidal models to avoid "exaggeration" in vertical scale, which disturbs the tidal analogy.

Yet elsewhere he clearly states that analogous bed movement in the model is **not** attained by such principles thus showing that in some **manner** geometrical similarity does not give a true natural analogy. Dr. Doodson also quite fairly shows that certain large "exaggerations" in the vertical scale of models have, in many cases, given results which are remarkably close to nature, even though tidal experts do not consider such agreement as anything like perfect.

He candidly admits that "there is a need for a more exhaustive examination of the factors involved and more experiments are needed to determine precisely how and where the failure to account for the frictional term is to some extent counteracted."

It is very clear that there is a set of principles governing variations in the relation between vertical and horizontal scales which satisfy the natural analogy relating large and small channels and their bed movements under conditions approaching what may be called natural equilibrium.

In confirmation of the above, it is remarkable that when certain relations between horizontal and vertical scales are adopted, the grain size of material most suitable for the reproduction of natural bed features is nearly the same as that found in nature.

The researches of Dr. Reynolds commencing in 1885 with his Mersey model which gave such spectacular results undoubtedly laid the foundations for the general purpose model directly relating river or tidal flow to mobile bed features and including all the variables involved.

The principal of dynamical similarity which gives the fraction

$$\frac{\sqrt[3]{\text{Denominator of vertical scale}}}{\text{Denominator of horizontal scale}}$$

as the relation of the model time to natural time became the basis for running off years of tidal cycles in periods measured by days and weeks and in some cases results have been obtained relating tidal levels, velocities, bed movements and stabilisation in a manner remarkably in conformity with nature.

Yet as that eminent and cautious Conservancy Officer, Captain F. W. Mace remarked, "my experience is that results from them must be accepted with considerable reserve."

On the other hand, the experience of the last sixty years has demonstrated a considerable range of achievement in the use of models and in the increasing light of research. The Hydraulic Research Organisation has been inaugurated to accelerate this progress and an appreciable advance has recently been made.

Perhaps I may be permitted to remark upon the practical aspects of this problem as a hydrographic surveyor acquainted with tidal and river flow in relation to Harbour Conservancy problems generally.

(1) It is clear that the general purpose model approximates to natural phenomena only when the vertical scale is increased and "exaggeration" must in such cases exceed the cube root of the denominator of the horizontal scale. Thus for Reynold's original Mersey model which employed a horizontal scale of 1/31,800 the "distortion" would be $\sqrt[3]{31,800}=31.6$ and it is remarkable that he in fact did use an "exaggeration" of 33.2.
Mr. Lacey was not slow to note that seeking and achieving natural equilibrium in alluvium had led to a knowledge of optimum relationships in nature. On the other hand his limits of distortion appear from model experience to be minima, especially when one considers the Severn model which doubles the Lacey figure.

(2) Furthermore, it would be inferred by many practical Conservators that discrimination between "straight" and "tortuous" channels in the choice of a "suitable" vertical scale is an admission that a true natural analogy in model technique involving precise definition commented upon by Drs. Doodson and Allen is not known to them.

(3) It is to the writer significant that when certain scales approximating or exceeding the Lacey rule for vertical scale in straight channel models are adopted, the actual size of the bed material in nature is closely approximated with analogous bed results.
Is a real correlation possible after close analysis of **all** the variables, and is the present very definitely controversial nexus an ante-chamber to wider spheres of co-ordination, and the correlation of at present apparently divergent reasoning and laws, developed by brilliant minds each specialising to a superlative degree in uni-lateral techniques?

Conservancy Officers and Hydraulic Research—continued

The writer respectfully holds the opinion that this is the case, and that healthy and even vigorous controversy amongst experts is not a bad but a good feature which must ultimately realise itself in that harmonious simplicity characteristic of all Nature when she is unveiled.

(4) The writer is indebted to Sir Claude Inglis, Director of Hydraulic Research, for several conceptions which incline him to the view that the study of equilibrium tendencies in alluvium of varying discharges is a sound preliminary for the fundamental study of these matters.

It is, I think, significant that when, in alluvium, the discharge in cusecs is reduced, width of channel is drastically reduced whilst diminution of depth is relatively small. This has been prominently stated by Professors Reynolds and Gibson, both eminent practical men.

In the light of this phenomenon, in material sufficiently amenable to reveal the optimum equilibrium tendencies in nature, is it in fact really correct to speak of " exaggerations " or " distortions " in the much controverted matter of vertical scale.

Is not a model analogy actually a stream, river or estuary **in its own right** as it were, and are not the natural, varying and related reductions in width and depth in such an analogy to be embodied in models with due regard to equations properly defining " sinuosity," and deviation from rectilinear flow?

It would seem that in Mr. Lacey's illuminating practical remarks on consistent increase of depth and modification of shape and axis in alluvium, for deviations from straight flow (p. 279 of paper, " Stable Channels in Alluvium ") are worthy of consideration and analysis in considering the " shock " analogy upon which Dr. Doodson so pertinently remarks.

In conclusion, perhaps as a hydrographic surveyor who has taken a close interest in models, I may be forgiven if I have seemed to enter an arena, but I am certain that final results must be understood by practical and scientifically minded Conservancy Officers if any valid assurance is to be given to Port Authorities that models on established principles are to indicate sound interpretations and solutions for their problems.

I would add to the above suggestions for a concerted attack by **a team** upon this problem, the need for trained geologists to be included to study the beds of estuaries affected by tidal flow and the historical factors affecting the mobility of material. It is emphasised that the mechanism used by nature in transporting detritus is exceedingly complex, and it is understood that the essential research on this problem is proceeding.

In such an " attack " it would seem that the present brilliant team of distinguished hydraulic and tidal scientists and physicists are clearly on the way to laying bare some basic and fundamental harmonies of nature, and it would appear to be imperative that every aid should now be given at this critical stage for the elucidation of these important matters.

150-ton Floating Crane for the Admiralty

The second of two 150-ton floating cranes ordered by the Admiralty is now being completed by Messrs. Cowans, Sheldon & Co., Ltd., Carlisle. These cranes are to replace those lost during the war, and the first has already reached its destination.

Each crane is mounted on a non-propelled steel pontoon 200-ft. long by 80-ft. wide with a moulded depth of 15-ft. 6-in., built by the Fairfield Shipbuilding & Engineering Co., Ltd. As will be seen from the illustrations, the crane is mounted at one end of the pontoon, and a trestle which supports the jib when the crane is in sea-going condition is fixed to the deck at the other end. The deck between the crane and the trestle is designed to carry

Floating Crane at Sea

a distributed load of 200 tons. The pontoon is divided into watertight compartments and its structure has been specially designed to carry the heavy loads imposed by the crane with a minimum of deflection for all positions and conditions of loading. It is also provided with very complete living accommodation for the crew and spare equipment storage compartments.

The construction of the cradle for the jib at the top of the trestle prevents loads, due to the flexing of the pontoon when at sea, being transmitted to the jib structure, and movement of the revolving portion of the crane during sea voyage is prevented by struts and ties which secure the crane to the deck of the pontoon. Four steam-driven capstans, each of a capacity of ten tons pull, are fitted on the deck of the pontoon.

The crane revolves on a ring of cast steel rollers running between cast steel paths and is pivotted on a steel centre pin which transmits vertical and horizontal forces to the girders of the pontoon. Mounted on the centre pin is a collector column, which transmits the electrical power to the various crane motors. The slewing motion is operated by two pinions and a spur rack.

The main power plant consists of two geared steam turbine-driven direct current generating sets which are housed in the pontoon. Each generating set is designed for a continuous output of 250 k.w. at 440 v., and are steamed by two vertical oil-fired multi-tubular boilers with a working pressure of 150 lbs. per square inch. The output of one generator set operates the crane under normal working conditions. The power supply for the vessel's light and battery charging switchboard is provided by a 22 k.w. motor generator when the crane is working, which is positioned in the engine room and driven from the main turbo generator. Two smaller oil engine-driven generator sets supply power at 110 v. for lighting and other auxiliary services.

The crane is of the derricking and full revolving type and is fitted with twin sets of main hoisting gear each capable of lifting 75 tons which, when coupled together, form a hoist of 150 tons capacity. The total range of lift of the main hoist motion is 180-ft. and each 75 ton block is suspended on six parts of wire rope. The crane is also fitted with a 40 ton auxiliary hoist suspended from the extreme end of the jib, and having a range of lift of 200-ft. In addition, a 10 ton transporter hoist travels on the lower boom of the jib. The block of this hoist operates on four parts of wire rope with a total height of lift of 160-ft. and is capable of travelling over a distance of 96-ft., the traversing motion being operated by means of wire rope.

The jib is 170-ft. long with its hinge pins situated 36-ft. above the deck of the pontoon, and the derricking motion is operated by two screws and links. The crosshead which carries the nuts for the screws is carried on bogies mounted on double-flanged cast steel wheels which run on inclined guide rails fixed to the sides of the crane structure, the derricking links being attached to the crosshead and to the lower end of the jib structure. The inclination of the guides for the crosshead permits the jib being lowered to a horizontal position where it is stored on its supporting trestle at one end of the pontoon. The jib can be lowered on to the trestle and raised under the crane's own power, and this interesting feature eliminates the use of independent lifting equipment on shore when preparing the crane for a sea voyage and when making ready for work after it reaches its destination.

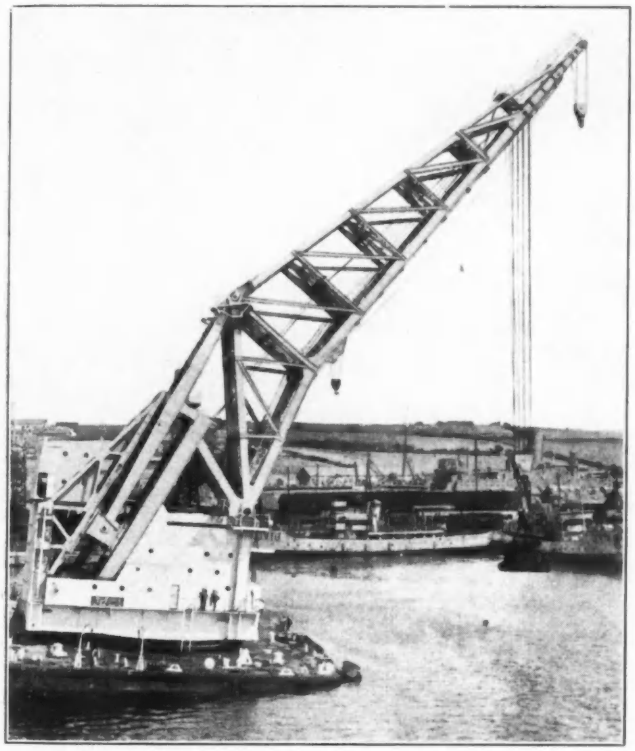
Two high pressure lubricating pumps mounted on the crosshead bogies, and driven by means of spur wheels on two of the rail wheels, lubricate the derricking screws when the motion is in

150-ton Floating Crane for the Admiralty—continued

operation, and wipers are also fitted to automatically clean the screws.

All machinery is enclosed in a weather-proof sheet steel house, certain panels of which can be removed to give easy access for removal and repair of the various gears. Hand-operated overhead pulley blocks and runways are fitted inside the house to enable the handling of machinery requiring replacement. A box housing ballast in the form of cast iron slabs is situated at the rear of the machinery house; also at the rear of the machinery house, and above the ballast box, is situated a sheet steel compartment in which are grouped the contactor and resistances for the various crane motions.

The operator's cabin, which is situated at the base of the jib and above the machinery house, is positioned to give a wide and uninterrupted view of the load in all positions. The cabin is fitted with a control desk, in which are grouped the operating



Crane Lifting 187-ton Test Load

levers, all of which are within easy reach and control of the one operator. Indicators showing the radius and maximum rated loads for various radii are fitted in the cabin, and a pendulum which indicates the heel of the vessel is also situated in the operator's cabin. Two electrically driven 4 h.p. friction winches are fitted at the front of the machinery house for the purpose of guiding the load.

The speeds, capacities and horse-powers of the various motors are as follows:—

SPEEDS.

Main Hoist	**150 tons at 8-ft. per minute.**
Blocks coupled	**75 tons at 16-ft. per minute.**
Main Hoist	**75 tons at 8-ft. per minute.**
Single block	**37½ tons at 16-ft. per minute.**
Auxiliary hoist	**40 tons at 17½-ft. per minute.**
Auxiliary hoist	**20 tons at 35-ft. per minute.**
Slewing	**150 tons at 1 rev. in 5 minutes.**
Derricking	**150 tons through full working range in 9 minutes.**
Derricking	**100 tons through full working range in 15 minutes.**
Derricking	**No load through full working range in 14 minutes.**
Derricking	**40 tons through full working range in 9½ minutes (aux. block).**
Transporter hoist ...	**10 tons at 60-ft. per minute.**
Transporter traverse ...	**10 tons at 65-ft. per minute.**

CAPACITIES.

Main blocks coupled ...	**150 tons at 60-ft. to 105-ft. radius.**
Main blocks coupled ...	**100 tons at 60-ft. to 125-ft. radius.**
Main blocks coupled ...	**80 tons at 60-ft. to 130-ft. radius.**
Main blocks coupled ...	**40 tons at 60-ft. to 140-ft. radius.**
Single main block ...	**75 tons at 60-ft. to 105-ft. radius.**
Single main block ...	**50 tons at 60-ft. to 125-ft. radius.**
Single main block ...	**40 tons at 60-ft. to 130-ft. radius.**
Single main block ...	**20 tons at 60-ft. to 140-ft. radius.**
Auxiliary block ...	**40 tons at 66-ft. to 140-ft. radius.**
Auxiliary block ...	**20 tons at 66-ft. to 167-ft. radius.**
With Jib at Minimum Radius:	
Transporter block ...	**10 tons at 25-ft. to 56-ft. radius.**
With Jib at Maximum Radius:	
Transporter block ...	**10 tons at 56-ft. to 142-ft. radius.**

HORSEPOWERS.

No. 1 main hoist	**80 b.h.p. at 750 r.p.m.**
No. 2 main hoist	**80 b.h.p. at 750 r.p.m.**
Auxiliary hoist	**80 b.h.p. at 750 r.p.m.**
Transporter hoist	**60 b.h.p. at 750 r.p.m.**
Transporter traverse ...	**60 b.h.p. at 750 r.p.m.**
Derrick	**160 b.h.p. at 530 r.p.m.**
Slewing	**2/30 b.h.p. at 600 r.p.m.**

The Humber Conservancy

Big Replacement Programme Foreshadowed

At the annual meeting of the Humber Conservancy Board held towards the end of last month, the Chairman, Mr. William Fenton, moving the adoption of the Report for 1948, said that the tonnage entering the Humber was still appreciably lower than in pre-war years. The average tonnage for the three pre-war years was about a third more than last year. They had, therefore, a long way to go to get back to the pre-war standard. Total receipts for 1948 were £69,408 and expenditure £73,474, a deficit of about £4,000.

Continuing, Mr. Fenton said that the total value of Conservancy funds was £153,835, but most, if not all of it, would probably be required during the next few years to meet expenditure on the replacement of certain units of floating property, the normal life of which had long expired. Ninety-one alterations were made during the past year in the position of floating marks on the River Humber. It was the highest number on record. The installation of a high-frequency radio telephone system between the offices of the Conservancy Board and specified floating units was expected to be put into operation in the near future. It should be of great help in securing prompt attention to matters affecting navigation.

The Board unanimously re-elected Mr. Fenton as chairman for the ensuing year, but in accepting office Mr. Fenton said it was his intention to retire a year hence. Mr. J. W. Bayley was re-elected vice-chairman. An agreement negotiated with the Transport and General Workers' Union in regard to remuneration and conditions of service of floating staff was approved by the Board.

New Dry Dock for Naples.

It has been announced that a dry dock that will take any ship in the world is to be built at Naples. The dock will have considerable strategic significance and will be 50 per cent. financed by the European Recovery authorities. It will be 1,059-ft. long, which is 36-ft. longer than the "Queen Mary."

The Port of Rio de Janeiro

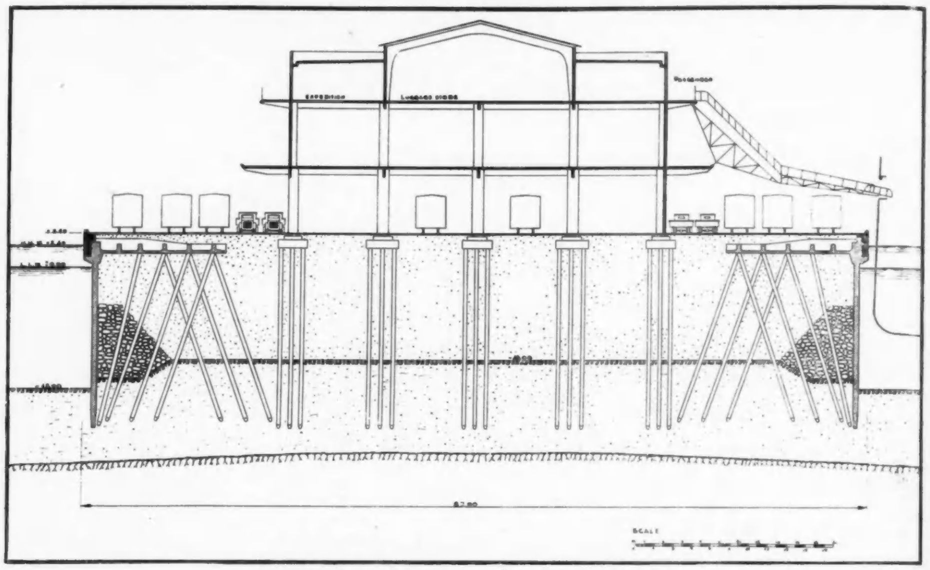
New Pier and Warehouses to be Constructed

The Harbour Administration of Rio de Janeiro, under the superintendence of Dr. F. V. de Miranda Carvalho, recently called for competitive tenders for the construction of a large pier.

The firms tendering were asked to submit their own design and twelve different proposals were submitted by six firms.

The Harbour Administration has now entrusted the work to Christiani--Nielsen, Engenheiros e Construtores S.A., who proposed to construct the pier as a sand-filled structure limited by a quay wall of the Christiani & Nielsen type at a cost of Cruzeiros 86,975,200,00 (£1,130,000).

The design of the pier is in many respects an unusual one. It has been planned to accommodate the world's largest liners and the water-depth alongside the quay as well as the overall dimensions of the pier are very large, with ample allowance for a substantial live load on the quay. Large quantities of mud will have to be removed in order to obtain a firm ground for the filling, and the bearing strata, which in some places is found to be at a great depth, is, in other places, encountered just below the present harbour bed, so that, in some places there will be difficulty in obtaining a sufficient driving depth for the steel sheet piling.

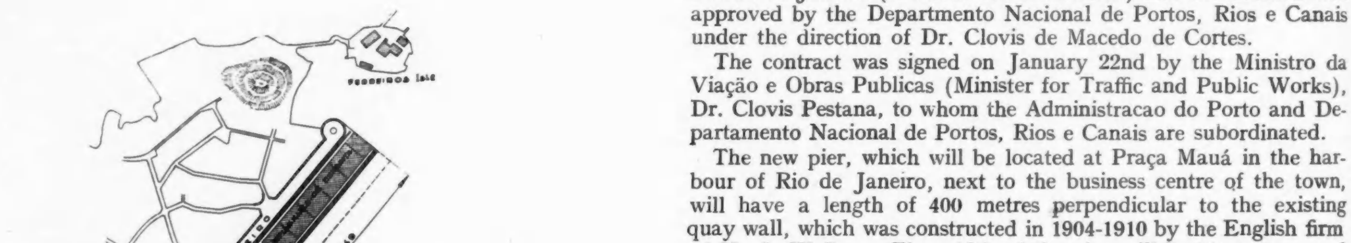


Typical Cross Section through Pier and Shed

The competition was organised by the Administracas do Porto do Rio de Janeiro (Harbour Administration) and the decision was approved by the Departmento Nacional de Portos, Rios e Canais under the direction of Dr. Clovis de Macedo de Cortes.

The contract was signed on January 22nd by the Ministro da Viação e Obras Publicas (Minister for Traffic and Public Works), Dr. Clovis Pestana, to whom the Administracao do Porto and Departamento Nacional de Portos, Rios e Canais are subordinated.

The new pier, which will be located at Praça Mauá in the harbour of Rio de Janeiro, next to the business centre of the town, will have a length of 400 metres perpendicular to the existing quay wall, which was constructed in 1904-1910 by the English firm of H. C. Walker. The width of the pier will be 83 metres, and the water depth 14.0 metres at low water and 15.4 metres at high water, and the total height of the quay wall is to be 16.6 metres. The quays will be equipped with railway tracks and travelling cranes and designed for a live load of 5 tons per sq. metre. Two 3-storey warehouses, which will include passenger facilities, are



Plan of the Port of Rio de Janeiro, showing (on right) location of proposed new Pier

The Port of Rio de Janeiro—continued

to be provided. The warehouses will be 150 metres long and 40 metres in width.

Roughly speaking, the ground consists of 3-4 metres of mud overlying 3-12 metres of sand, clay and decomposed rock lying upon the rock. The rock surface is found at depths varying from 14-22 metres below the low water level. The present water depth is 4-10 metres reckoned from the same level.

Artist's impression of Completed Warehouses

The pier structure comprises a sand filling confined by a quay wall of the Christiani & Nielsen type, and a pile foundation for the warehouses. Generally, the filling will be sand, but a stone filling will be used immediately behind the steel sheet piling.

The soft strata inside the pier wall is to be removed to a depth of 10 metres and replaced by sand. The warehouses will be founded on re-inforced concrete piles, the ground floor being supported on the filling. The foundation of the warehouses is included in the contract, but the warehouses proper are excluded and have not yet been designed or contracted for, those indicated in the accompanying photograph and drawing being merely suggestions.

The Port of Chittagong

Extensive Development Plans Approved

It has been announced that plans for developing Chittagong, the chief port of Eastern Pakistan, into one of the major ports in the east, and for developing the Chittagong Valley on lines similar to the Tennessee Valley Authorities in the U.S.A., have been approved by the Government of Pakistan. Financial sanction has already been obtained, and a scheme has been prepared by two British and one Swedish engineering firms who are working together on the project.

The Pakistan Government is making strenuous efforts to put the plans into effect as early as possible by procuring the necessary technical aid and equipment. It will almost certainly have to call in foreign engineering firms. The Chittagong Valley has vast potentialities for the development of hydro electricity and the wholesale expansion of agriculture and industries.

The overall scheme provides for a short-term and a long-term plan. Under the short-term scheme, the berthing capacity of Chittagong Port is to be expanded by 1950 from a million tons a year to 2,500,000 tons. Other provisions under this scheme include the introduction of a Government-owned fleet of boats for linking up interior waterways with Chittagong, the provision of floating warehouses, and the creation of additional mooring facilities. It is expected this part of the work will take 5 years to complete.

The long-term plan, which is expected to be completed in 10 years, provides for the construction of 14 additional berths at Chittagong, and the re-erection of an import and export yard.

Apart from these plans, the Royal Pakistan Navy is making a thorough survey of the estuaries of the Rivers Meghna, Breswar and Pussar, with a view to finding a channel deep enough for an additional port for East Pakistan.

The Port of London

Reconstruction and Improvement Works

Dock development, comprising the redevelopment of the South Quay, West India Dock, the reconstruction of the Millwall Entrance Lock and the purchase of 117 additional cranes, was recently authorised by the Port of London Authority.

The re-development of the South Quay, West Lndia Dock, known as "Rum Quay," to provide additional berthing facilities for deep-sea vessels, entails the construction of a false quay 1,320-ft. long with a minimum depth of 29-ft. alongside, and the erection of two warehouses with road, rail and crane facilities. Part of this quay was badly damaged by a serious fire in 1933 and the remainder was destroyed by enemy action in 1940. The total cost of the scheme is estimated at £400,000.

In order to meet craneage requirements over the next four years, the Authority have decided to purchase 117 additional cranes at a cost of £898,500, comprising 82 quay cranes and 35 mobile cranes of various types and capacities ranging from 1 to 12½ tons. There are at present 502 quay cranes available in the docks and a further 30 quay cranes are already on order.

A scheme for the reconstruction of the Millwall Entrance Lock was approved by the Authority in August, 1939, but owing to the outbreak of war it was deferred indefinitely. During the war the lock suffered heavy damage and was closed to shipping. Recently the scheme has been reconsidered and the Authority have now approved the reconstruction of the lock at a cost of £300,000. The dimensions are: Length 450-ft., width 80-ft. and depth 28-ft. below T.H.W. at the centre of the cill.

Recovery in Port Traffic

At a meeting of the Authority held subsequently, the Chairman, Sir John Anderson, M.P., referred to the completion of the fortieth year of the Authority's life, and then reviewed the progress made during the past three years to bring the port back to a state of efficiency comparable to the years before the war. The magnitude of this task could be seen from the fact that the Authority's war damage claim has been agreed at a figure of approximately £13,500,000, in addition to which there were arrears of maintenance and dredging of the order of some £5,000,000.

During the years under review the commercial trade of the port had shown a steady increase from the low ebb to which it had shrunk during the war, as was shown by the following figures:—

Shipping Arrived and Departed	Tons net
Year ended Mar. 31, 1939	62,085,840
Year ended Mar. 31, 1947	34,811,540
Year ended Mar. 31, 1948	41,372,625
Year ended Mar. 31, 1949 (est.)	45,500,000

Imports and Exports	Imports Tons	Exports Tons
Year ended Mar. 31, 1939	34,098,315	7,563,748
Year ended Mar. 31, 1947	Not available	
Year ended Mar. 31, 1948	30,649,820	5,728,431
Year ended Mar. 31. 1949 (est.) ...	31,430,000	7,439,000

Two salient features of the trade of the port in these post-war years compared with the trade up to 1939, were worth mentioning:

(1) While the shipping tonnages were but two-thirds of the pre-war figures, the available berthing accommodation was more hardly pressed by reason of the extended periods during which the majority of vessels, which were generally fully loaded, now occupied their berths.

(2) The tonnage of goods handled over the Authority's quays bore a higher proportion to the total tonnage for the port, particularly so far as exports were concerned. This might be attributed partly to the effect of war damage to dock and riverside property and partly to a change in the composition of the traffic.

Sir John Anderson concluded by saying that while the Port of London had the benefit of increasing trade, unfortunately the costs of operation, both capital charges and running expenses, had shown a steep rise. New equipment was costing between two and three times as much as before the war. A deficit of £550,000 with which the Authority had started in 1946 had been cleared and it was hoped that the trend of events during the next three years would be towards a better balanced economy.

Notes of the Month

Floodlighting Tyne Dock.

A sub-committee of the Tyne Improvement Commission is enquiring into methods of floodlighting the west side of its Tyne Dock. Enquiries of experience in this type of lighting have been made from the Falmouth Docks and Engineering Company, Ltd., British Railways, North Eastern Region, and the Port of Antwerp.

New Zealand Harbour Boards Amendments.

Twenty-three trades unionists have been appointed members of 16 harbour boards throughout New Zealand under the terms of the Harbours Amendment Act passed last year. They include representatives of the watersiders, harbour employees, foremen and stevedores, seamen, drivers unions, tally clerks, shipwrights, railwaymen and others. The appointments are three members each for the Auckland, Wellington and Otago Boards, two for Lyttelton, and one each for 12 smaller boards.

Beira Port Agreement.

An international agreement to facilitate development of the Port of Beira in Portuguese East Africa is now being negotiated. The agreement accept the economic and strategic importance of the port and stipulates that, provided the Port of Beira facilities are adequate to cater for the traffic requirements of the Central African territories and provided freight charges on the Beira Railways are such as not to make traffic uneconomic, the Central African territories undertake that they will not permit any manipulation of rates which would have the effect of diverting traffic from Beira.

Hull Port Advisory Committee.

Prospects of a speeding-up in the restoration of the war-damaged Riverside Quay at Hull, were indicated when Sir Robert Letch and Mr. John Donovan, of the Docks and Inland Waterways Executive, recently visited the port and met representatives of all organisations connected with the working of the docks. Reporting on this meeting to the Hull Chamber of Commerce and Shipping early last month, the President (Mr. W. R. Todd) said it was gathered that the Executive was doing all it could to push forward the partial restoration of the quay. Provision of improved accommodation at King George Dock was also being considered and a port advisory committee was to be set up, through which users of the port would be able to put their views before the Executive.

Liverpool Lock Repaired.

The Gladstone-Hornby Lock at Liverpool, which was very badly damaged by enemy action, has now been repaired and placed in commission again. The work which was commenced at the end of 1945 was in the nature of a major repair and involved the construction of a dam at the south end of the lock and the placing in position of a 100-ft. caisson at the middle gate recess to enable half of the lock to be dried out. The cost of the repairs was about £195,000, and a full description of the work involved appeared in the March, 1948 issue of this Journal. Now that the work is completed, the lock can be used to its full capacity in passing ships using the Gladstone river entrance lock into the adjacent docks to the southward.

Port of Bombay Development Plans

Plans to develop and modernise the Port of Bombay, reported to be under consideration by the Bombay Port Trust, include a new entrance lock for the Princess and Victoria Docks to facilitate the entry of all types of vessels at any time, irrespective of tides, and the construction of a new dry dock. Other projects include a five-year scheme for a ship-building yard, estimated to cost Rs. 2.5 crores, drawn up by the Chief Engineer of the Bombay Port Trust and submitted for approval to the Government of India's Ship-Building Committee of which he is a member. It is proposed to have the yard about 15 miles north-east of Bombay, with ship-ways to allow the construction of ten vessels, each of up to 15,000 tons, at the same time. Space will be provided for further expansion. Another plan has also been devised for moving the Admiralty dockyard to Bombay, where construction of naval vessels could also be undertaken.

SITUATION VACANT

PORT OF BRISTOL AUTHORITY

Applications are invited for the post of MARINE AND DREDGING (SECOND) ASSISTANT to the Chief Engineer The senior post of Marine and Dredging Assistant falls vacant in a few years time.

Candidates should not be more than 35 years. Training and experience in repairs and maintenance of dredgers and other harbour floating plant (hulls and machinery) is essential, and candidates should preferably have had experience in the carrying out of operations connected with dredging requirements. Office experience, including the preparation of reports, estimates, etc., will be an advantage.

Salary applicable to post is £520 per annum rising by annual increments to £570, but commencing salary will be adjusted according to qualifications and experience of selected candidate. Position superannuable in accordance with provisions Local Government Superannuation Act 1937, and successful candidate required to pass medical examination. Applicants must disclose whether related to a member or senior officer of Bristol Corporation. Canvassing disqualifies.

Applications stating age and other relative particulars and enclosing copies of recent testimonials must reach the undersigned by 10.0 a.m. on Friday the 27th May, 1949.

Port of Bristol Authority, Avonmouth Docks, Bristol.

N. A. MATHESON, Chief Engineer.

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